RUL-7-2-40

Nevada Environmental Restoration Project

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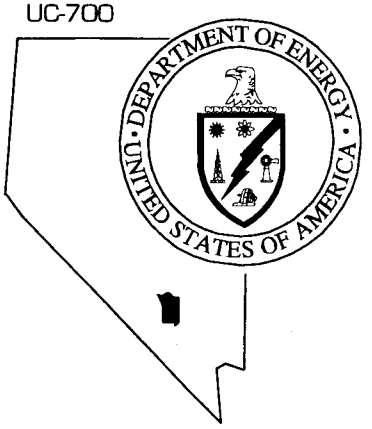


# Rulison Drilling Effluent Pond Site Long-Term Groundwater Monitoring Plan

July 1996

Environmental Restoration Division

U.S. Department of Energy
Nevada Operations Office

DOE/NV--441
UC-700

# RULISON DRILLING EFFLUENT POND SITE LONG-TERM GROUNDWATER MONITORING PLAN

DOE Nevada Operations Office
Las Vegas, Nevada

July 1996

**RULISON DRILLING EFFLUENT POND SITE**
**LONG-TERM GROUNDWATER MONITORING PLAN**

Approved: Janet Appenzeller-Wing Date: 7/1/96

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## List of Acronyms and Abbreviations

| | |
|---|---|
| BGS | Below ground surface |
| CCR | Code of Colorado Regulations |
| COC | Contaminant of concern |
| DOE | U.S. Department of Energy |
| EPA | U.S. Environmental Protection Agency |
| ESSC | Environmental Services Support Contractor |
| ft | Foot (feet) |
| in. | Inch(es) |
| km | Kilometer(s) |
| m | Meter(s) |
| MS/MSD | Matrix spike and matrix duplicate sample |
| PVC | Polyvinyl chloride |
| QAPP | Quality Assurance Project Plan |
| QC | Quality control |
| SCS | U.S. Soil Conservation Service |
| SSHASP | Site-Specific Health and Safety Plan |
| VOC | Volatile organic compound |

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# 1.0 Introduction

The purpose of this groundwater monitoring plan (GMP) is to provide guidance for collecting and analyzing groundwater samples from eight monitoring wells installed during the remediation of the Rulison Drilling Effluent Pond Site for a period of 30 years. This plan is intended to comply with the state of Colorado groundwater monitoring requirements in *Regulations Pertaining to Solid Waste Disposal Sites and Facilities,* 6 Colorado Code of Regulations (CCR) 1007-2, Part A, Appendix B (CCR, 1994).

## 1.1 Project Description and Background

Project Rulison was a joint U.S. Atomic Energy Commission and Austral Oil Company experiment conducted as part of the Plowshare Program to test the feasibility of using a nuclear device to increase natural gas production in low-permeability gas-producing geologic formations. The experiment was conducted on September 10, 1969, and consisted of detonating a 40-kiloton device at a depth of 2,568 meters (m) (8,426 feet [ft]) below ground surface (BGS). Production testing was conducted in 1970 and 1971. Some surface contamination resulted from decontamination of drilling equipment and fallout from the gas flaring (DRI, 1988). Aside from the cleanup of the drilling effluent pond, all surface contamination was removed during site clean-up operations in 1976.

## 1.2 Location

The Rulison Site is located in the North ½ of the Southwest ¼ of Section 25, Township 7 South, Range 95 West, Garfield County, Colorado, approximately 19 kilometers (km) (12 miles) southwest of Rifle, Colorado, and approximately 65 km (40 miles) northeast of Grand Junction, Colorado (Figure 1-1).

The site is situated on the north slope of Battlement Mesa on the upper reaches of Battlement Creek, at an elevation of approximately 2,500 m (8,200 ft). The valley is open to the north-northwest and is bounded on the other three sides by steep mountain slopes that rise to elevations above 2,927 m (9,600 ft). The drilling effluent pond is triangular in shape and covers approximately 0.5 acre. It is approximately 6 m (20 ft) deep from the top of the berm to the pond bottom and is located approximately 400 m (1,312 ft) north-northwest of the original surface-ground-zero emplacement well. The pond originally contained drilling fluids, but was converted to a freshwater holding pond containing aquatic vegetation, amphibians, and stocked rainbow

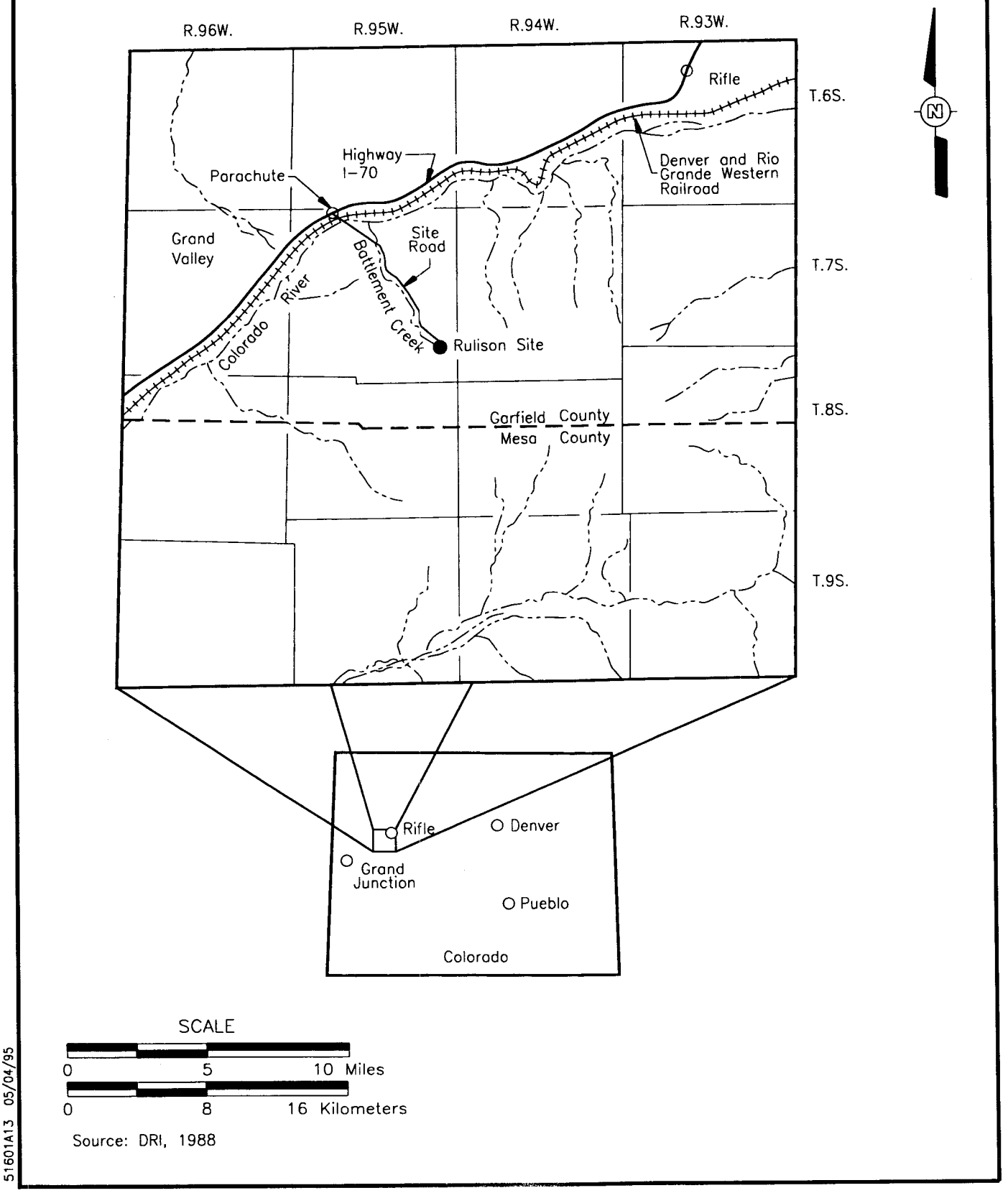


**Figure 1-1**
**Rulison Site Location Map**

trout. The pond was left in place at the request of the land owner (ERDA, 1977) and is fenced to prevent access by wildlife and livestock.

### 1.3 Previous Studies

The drilling effluent pond at the Rulison Site was used to store nonradioactive drilling wastes resulting from the drilling of the device Emplacement Well R-E. Cuttings and most of the drilling fluid were excavated, transported off site, and properly disposed. The drilling fluids consisted of bentonitic drilling mud with various additives, such as diesel fuel and chrome lignosulfonate used to improve drilling characteristics. Most of the drilling wastes were removed from the pond when the site was cleaned up and decommissioned in 1976; however, some fluid was left in the pond. In 1994 and 1995, three pond-sediment sampling events were conducted to evaluate the nature of this residual drilling fluid. Surface water, soil, and sediment samples were collected. The primary contaminants detected in soil and sediment samples were total petroleum hydrocarbons (TPH) as diesel, benzene, ethylbenzene, tolune, xylene, chromium, lead, and barium. All analytical results of surface water samples were clean with no petroleum compounds or metals identified. The specific results of the sampling events are presented in Tables 1-1 through 1-6 below. Also included are state of Colorado and federal clean-up standards for heavy metals and organic compounds in soils. Colorado discharge standards for water are site-specific and will be specified in the water discharge permit.

### 1.4 Summary of Site Remediation Activities

Remediation closure of the drilling-effluent pond sediments is proposed for September 30, 1995. Based on the current knowledge of site conditions, this remediation activity includes draining the pond, removing and stabilizing the sediments, and the transportation of the stabilized sediments to an approved landfill. Following sediment removal and verification sampling, the pond will be restored. As part of this restoration, eight groundwater monitoring wells will be installed. Specific information about the proposed remedial activity is presented in the Rulison Corrective Action Plan (DOE, 1995a).

### 1.5 Site Hydrogeology

#### 1.5.1 Site Geology

The surficial geology consists of Quaternary deposits comprised of mudflows, talus accumulations, fan and pediment gravel, and the alluvium of Battlement Creek. These deposits are expected to range from 6 to 12 m (20 to 40 ft) in thickness, but may be more than 30 m (100 ft) thick (Voegeli et al., 1970) locally.

# Table 1-1
## Sediment Sampling Results for Rulison Drilling Effluent Pond
(Page 1 of 3)

| Compound | Regulatory Limit | Sampling Conducted in September 1994 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Sediment Samples | | | | | | | | | | | |
| | | SD-01 | Q[a] | SD-02 | Q | SD-03 | Q | SD-04 | Q | SD-05 | Q | EQ-01[c] | Q |
| **Total Metals (mg/kg)** | | | | | | | | | | | | µg/L | |
| Aluminum | | 11,700 | | 13,400 | | 32,300 | | 61,500 | | 30,700 | | 56.7 | B |
| Antimony | | 0.72 | B[a] | 0.57 | U[a] | 0.81 | U | 1.5 | U | 3.7 | U | 1.8 | U |
| Arsenic | 100[b] | 7.6 | | 7.1 | | 15.5 | | 31.6 | | 12.9 | B | 1.8 | U |
| Barium | 2,000[b] | 158 | | 179 | | 395 | | 1,140 | | 816 | | 2.2 | B |
| Beryllium | | 0.79 | B | 0.78 | B | 1.8 | B | 4.8 | | 2.4 | B | 0.39 | B |
| Cadmium | 20[b] | 1.3 | U | 1.2 | U | 1.7 | U | 3.1 | U | 7.6 | U | 3.7 | U |
| Calcium | | 18,800 | | 17,800 | | 16,700 | | 53,500 | | 37,300 | | 26.5 | B |
| Chromium | 100[b] | 20.6 | | 29.7 | | 55.9 | | **114** | | **2,170** | | 3.4 | U |
| Cobalt | | 8.3 | B | 8.9 | B | 15.8 | B | 34.4 | B | 19.1 | B | 3.2 | U |
| Copper | | 20.5 | | 22.1 | | 47.7 | | 95.8 | | 164 | | 7.4 | B |
| Iron | | 17,900 | | 16,100 | | 36,300 | | 71,300 | | 37,200 | | 66.1 | B |
| Lead | 100[b] | 13.2 | | 8.5 | | 30.6 | | 68.9 | | **427** | | 1.4 | B |
| Magnesium | | 7,360 | | 6,540 | | 12,800 | | 29,500 | | 16,900 | | 84.7 | B |
| Manganese | | 243 | | 287 | | 670 | | 1,460 | | 883 | | 2.1 | B |
| Mercury | 4[b] | 0.11 | B | 0.08 | B | 0.11 | U | 0.42 | | 0.90 | B | 0.10 | U |
| Nickel | | 17.2 | | 20.4 | | 42.1 | | 89.3 | | 60.7 | B | 15.5 | U |
| Potassium | | 2,200 | | 1,990 | | 3,890 | | 12,500 | | 8,620 | B | 1,940 | U |
| Selenium | 20[b] | 0.50 | B | 0.41 | U | 0.59 | U | 1.1 | U | 2.7 | U | 1.3 | U |
| Silver | 100[b] | 1.3 | U | 1.2 | U | 1.7 | U | 3.1 | U | 7.6 | U | 3.7 | U |
| Sodium | | 820 | B | 505 | B | 852 | B | 5,220 | | 1,970 | B | 459 | B |
| Thallium | | 0.51 | U | 0.47 | U | 0.68 | U | 1.2 | U | 3.1 | U | 1.5 | U |
| Vanadium | | 38.1 | | 35.3 | | 75.5 | | 129 | | 57.1 | B | 3.1 | U |
| Zinc | | 58.3 | | 49.5 | | 103 | | 178 | | 191 | | 12.5 | B |
| **TCLP Metals (mg/L)** | | | | | | | | | | | | mg/L | |

Refer to footnotes at end of table.

# Table 1-1
## Sediment Sampling Results for Rulison Drilling Effluent Pond
(Page 2 of 3)

| Compound | Regulatory Limit | Sampling Conducted in September 1994 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Sediment Samples | | | | | | | | | | | |
| | | SD-01 | Q[a] | SD-02 | Q | SD-03 | Q | SD-04 | Q | SD-05 | Q | EQ-01[c] | Q |
| Chromium | 5[d] | NA[e] | | NA | | NA | | NA | | 0.066 | | NA | |
| Lead | 5[d] | NA | | NA | | NA | | NA | | 0.042 | U | NA | |
| **TPH (mg/kg)** | | | | | | | | | | | | **mg/L** | |
| Nonspecific | 250[f] | NA | | 15.8 | U | NA | | 17,000 | | 72,600 | | NA | |
| Gas | | NA | | NA | | NA | | NA | | NA | | NA | |
| Diesel | | NA | | NA | | NA | | NA | | NA | | NA | |
| Waste Oil | | NA | | NA | | NA | | NA | | NA | | NA | |
| **BTEX ($\mu$g/kg)** | | | | | | | | | | | | **$\mu$g/L** | |
| Benzene | [g] | NA | | NA | | NA | | NA | | NA | | NA | |
| *Toluene* | [g] | NA | | NA | | NA | | NA | | NA | | NA | |
| Ethylbenzene | [g] | NA | | NA | | NA | | NA | | NA | | NA | |
| Xylene | [g] | NA | | NA | | NA | | NA | | NA | | NA | |
| Total BTEX | 50,000 | NA | | NA | | NA | | NA | | NA | | NA | |
| **PCB ($\mu$g/kg)** | | | | | | | | | | | | **$\mu$g/L** | |
| Aroclor-1016 | | NA | | NA | | NA | | 140 | U | 340 | U | NA | |
| Aroclor-1221 | | NA | | NA | | NA | | 140 | U | 340 | U | NA | |
| Aroclor-1232 | | NA | | NA | | NA | | 140 | U | 340 | U | NA | |
| Aroclor-1242 | | NA | | NA | | NA | | 140 | U | 340 | U | NA | |
| Aroclor-1248 | | NA | | NA | | NA | | 140 | U | 340 | U | NA | |
| Aroclor-1254 | | NA | | NA | | NA | | 140 | U | 340 | U | NA | |
| Aroclor-1260 | | NA | | NA | | NA | | 140 | U | 340 | U | NA | |

Refer to footnotes at end of table.

# Table 1-1
## Sediment Sampling Results for Rulison Drilling Effluent Pond
(Page 3 of 3)

| Compound | Regulatory Limit | Sampling Conducted in September 1994 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Sediment Samples | | | | | | | | | | | |
| | | SD-01 | Q[a] | SD-02 | Q | SD-03 | Q | SD-04 | Q | SD-05 | Q | EQ-01[c] | Q |
| **Gross Alpha/Beta (pCi/g)** | | | | | | | | | | | | pCi/ℓ | |
| Gross Alpha | | 15.6 | | 14.6 | | 7.72 | | 11.6 | | 6.56 | | 0.27 | |
| 2 Sigma Error (+/-) | | 5.0 | | 4.9 | | 3.74 | | 4.5 | | 3.58 | | 0.16 | |
| MDA[h] | | 5.0 | | 5.0 | | 5.18 | | 5.3 | | 5.23 | | 0.21 | |
| Gross Beta | | 25.8 | | 24.4 | | 22.4 | | 20.6 | | 17.4 | | -0.003 | |
| 2 Sigma Error (+/-) | | 3.9 | | 3.7 | | 3.4 | | 3.3 | | 2.9 | | 0.046 | |
| MDA | | 3.7 | | 3.6 | | 3.2 | | 3.5 | | 3.1 | | 0.665 | |
| **Gamma Spec. (pCi/g)** | | | | | | | | | | | | pCi/ℓ | |
| Cesium-137 | | ND[i] | | ND | | ND | | ND | | ND | | ND | |
| Potassium-40 | | 22.1 | | 24.4 | | 17.5 | | 15.2 | | 11.2 | | ND | |
| Lead-212 | | ND | | 1.30 | | ND | | 1.06 | | 1.23 | | ND | |
| Radium-226 | | 0.91 | | 0.75 | | ND | | ND | | ND | | ND | |

[a] Q = Laboratory assigned data qualifier: U = Compound was analyzed for but not detected; B = In organics, the analyte was found in the blank. In inorganics, the result is above the Instrument Detection Limit but below the Contract Required Detection Limit.
[b] No regulations for these soil parameters are specified in the Colorado Department of Health "Storage Tank Facility Owner/Operator Guidance Document." Regulatory limits are based on 20X the RCRA "Maximum Concentration of Contaminants for the Toxicity Characteristic."
[c] Quality Assurance Sample
[d] No regulations for these soil parameters are specified in the Colorado Department of Health "Storage Tank Facility Owner/Operator Guidance Document." Regulatory limits are based on RCRA "Maximum Concentration of Contaminants for the Toxicity Characteristic."
[e] The sample was not analyzed for that parameter.
[f] This limit is based on regulations specified in the Colorado Department of Health "Storage Tank Facility Owner/Operator Guidance Document."
[g] No individual regulatory level for this parameter, it is combined as Total BTEX.
[h] Minimum Detectable Activity
[i] Nondetect means the analyte was not found in the sample at a concentration above the instrument detection limit.

mg/kg = milligram per kilogram
pCi/g = picocurie per gram
pCi/L = picocurie per liter
mg/L = milligram per liter
µg/L = microgram per liter
µg/kg = microgram per kilogram

# Table 1-2
## Sediment Sampling Results for Rulison Drilling Effluent Pond
(Page 1 of 2)

| Compound | Regulatory Limit | Sampling Conducted in October 1994 | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Sediment Samples | | | | | | | | | | | | | | | | | |
| | | SD-06 | Q[a] | SD-07 | Q | SD-08 | Q | SD-09 | Q | SD-10 | Q | SD-11 | Q | SD-12 | Q | SD-13[b] | Q | WFR-O[c] | Q |
| **Total Metals (mg/kg)** | | | | | | | | | | | | | | | | | | µg/L | |
| Aluminum | | 7,830 | | 1,930 | | 2,300 | | 3,270 | | 3,250 | | 4,160 | | 1,830 | | 2,160 | | 37.4 | B |
| Antimony | | 0.36 | U | 0.36 | U | 0.36 | U | 0.36 | U | 0.36 | U | 0.36 | U | 0.36 | U | 0.36 | U | 1.8 | U |
| Arsenic | 100[d] | 3.5 | | 0.60 | B | 0.97 | B | 0.72 | B | 0.56 | B | 2.3 | | 1.1 | B | 0.69 | B | 1.0 | U |
| Barium | 2,000[d] | 132 | | 100 | | 87.8 | | 152 | | 174 | | 96.3 | | 71.3 | | 88.0 | | 1.8 | B |
| Beryllium | | 0.56 | B | 0.39 | B | 0.39 | B | 0.39 | B | 0.43 | B | 0.39 | B | 0.26 | B | 0.30 | B | 0.29 | B |
| Cadmium | 20[d] | 1.1 | | 0.74 | U | 0.74 | U | 0.74 | U | 0.74 | U | 0.74 | U | 0.74 | U | 0.74 | U | 3.7 | U |
| Calcium | | 16,100 | | 5,340 | | 5,960 | | 7,060 | | 6,690 | | 13,600 | | 6,510 | | 5,960 | | 130 | B |
| Chromium | 100[d] | 22.3 | | **187** | | **233** | | **343** | | **317** | | **106** | | **214** | | **206** | | 3.5 | B |
| Cobalt | | 5.0 | B | 1.4 | B | 1.6 | B | 2.0 | B | 2.6 | B | 1.8 | B | 0.84 | B | 1.5 | B | 3.2 | U |
| Copper | | 17.0 | | 9.0 | | 10.9 | | 13.4 | | 9.6 | | 11.6 | | 7.3 | | 10.6 | | 10.0 | B |
| Iron | | 11,700 | | 3,410 | | 3,980 | | 5,560 | | 5,000 | | 5,380 | | 2,670 | | 3,570 | | 72.2 | B |
| Lead | 100[d] | 8.3 | | 10.1 | | 11.3 | | 13.3 | | 9.2 | | 8.1 | | 28.8 | | 13.9 | | 1.0 | U |
| Magnesium | | 4,300 | | 1,590 | | 1,930 | | 2,220 | | 2,230 | | 2,590 | | 1,250 | | 1,760 | | 133 | B |
| Manganese | | 148 | | 79.8 | | 115 | | 111 | | 99.2 | | 81.6 | | 74.3 | | 106 | | 3.6 | B |
| Mercury | 4[d] | 0.05 | U | 0.05 | U | 0.05 | U | 0.05 | U | 0.05 | U | 0.05 | U | 0.05 | U | 0.05 | U | 0.16 | B |
| Nickel | | 15.6 | | 4.3 | B | 4.8 | B | 7.3 | B | 8.0 | B | 5.1 | B | 3.5 | B | 5.4 | B | 15.5 | U |
| Potassium | | 1,560 | | 527 | B | 902 | B | 1,350 | | 1,420 | | 877 | B | 389 | U | 553 | B | 1,940 | U |
| Selenium | 20[d] | 0.28 | B | 0.26 | U | 0.26 | U | 0.26 | U | 0.26 | U | 0.26 | U | 0.26 | U | 0.26 | U | 1.3 | U |
| Silver | 100[d] | 0.74 | U | 0.74 | U | 0.74 | U | 0.74 | U | 0.74 | U | 0.74 | U | 0.74 | U | 0.74 | U | 3.7 | U |
| Sodium | | 368 | B | 264 | B | 218 | B | 1,630 | | 973 | B | 351 | B | 233 | B | 288 | B | 181 | B |
| Thallium | | 0.30 | U | 0.30 | U | 0.30 | U | 0.30 | U | 0.30 | U | 0.30 | U | 0.30 | U | 0.30 | U | 1.5 | U |
| Vanadium | | 19.2 | | 3.8 | B | 4.0 | B | 6.1 | B | 6.8 | B | 10.9 | | 3.7 | B | 4.1 | B | 4.9 | B |
| Zinc | | 36.7 | | 21.3 | | 22.7 | | 29.5 | | 23.6 | | 23.0 | | 14.0 | | 20.1 | | 7.4 | B |

Refer to footnotes at end of table.

# Table 1-2
# Sampling Results for Rulison Drilling Effluent Pond
(Page 2 of 2)

| Compound | Regulatory Limit | Sampling Conducted in October 1994 | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Sediment Samples | | | | | | | | | | | | | | | | | |
| | | SD-06 | Q[a] | SD-07 | Q | SD-08 | Q | SD-09 | Q | SD-10 | Q | SD-11 | Q | SD-12 | Q | SD-13[b] | Q | WFR-O[c] | Q |
| **TCLP Metals (mg/L)** | | | | | | | | | | | | | | | | | | | |
| Chromium | 5[e] | NA[f] | | NA | | NA | | 0.44 | | NA | | NA | | NA | | NA | | NA | |
| Lead | 5[e] | NA | | NA | | NA | | NA | | NA | | NA | | NA | | NA | | NA | |
| **TPH (mg/kg)** | | | | | | | | | | | | | | | | | | **µg/L** | |
| Nonspecific | 250[g] | NA | | NA | | NA | | NA | | NA | | NA | | NA | | NA | | NA | |
| Gas | | 0.50 | U | 250 | | 28 | | 79 | | 260 | | 260 | | 210 | | 7.6 | * | 100 | U |
| Diesel | | 24 | U | 4,800 | | 15,000 | | 9,600 | | 11,000 | | 4,400 | | 10,000 | | 12,000 | | 500 | U |
| Waste Oil | | 34 | | 2,500 | U | 490 | U | 250 | U | 2,400 | U | 250 | U | 240 | U | 500 | U | 500 | U |
| **BTEX (µg/kg)** | | | | | | | | | | | | | | | | | | **µg/L** | |
| Benzene | [h] | 2.0 | U | 27 | | 2.0 | U | 26 | | 14 | | 26 | | 19 | | 2.0 | U | NA | |
| Toluene | [h] | 2.0 | U | 690 | | 9.5 | | 660 | | 700 | | 310 | | 370 | | 31 | | NA | |
| Ethylbenzene | [h] | 2.0 | U | 980 | | 29 | | 880 | | 990 | | 890 | | 1,200 | | 62 | | NA | |
| Xylene | [h] | 2.0 | U | 4,300 | | 160 | | 3,800 | | 4,400 | | 4,100 | | 5,200 | | 300 | | NA | |
| Total BTEX | 50,000 | | U | 5,997 | | 200.5 | | 5,366 | | 6,104 | | 5,326 | | 6,789 | | 395 | | NA | |

[a] Q = Laboratory assigned data qualifier: U = Compound was analyzed for but not detected; B = In organics, the analyte was found in the blank. In inorganics, the result is above the Instrument Detection Limit but below the Contract Required Detection Limit.
[b] Duplicate sample of SD-08
[c] Quality Assurance Sample
[d] No regulations for these soil parameters are specified in the Colorado Department of Health "Storage Tank Facility Owner/Operator Guidance Document." Regulatory limits are based on 20X the RCRA "Maximum Concentration of Contaminants for the Toxicity Characteristic."
[e] No regulations for these soil parameters are specified in the Colorado Department of Health "Storage Tank Facility Owner/Operator Guidance Document." Regulatory limits are based on RCRA "Maximum Concentration of Contaminants for the Toxicity Characteristic."
[f] The sample was not analyzed for that parameter.
[g] This limit is based on regulations specified in the Colorado Department of Health "Storage Tank Facility Owner/Operator Guidance Document."
[h] No individual regulatory level for this parameter, it is combined as Total BTEX.

*Value outside of QA limits

mg/kg = milligram per kilogram
µg/kg = microgram per kilogram
mg/L = milligram per liter
µg/L = microgram per liter

# Table 1-3
## Sediment Sampling Results for Rulison Drilling Effluent Pond
(Page 1 of 2)

| Compound | Regulatory Limit | Analytical Results for Sampling Conducted in April 1995 | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Sediment Samples | | | | | | | | | | | | | | | | | |
| | | SD-14 | Q[a] | SD-15 | Q | SD-16 | Q | SD-17 | Q | SD-18 | Q | SD-19[b] | Q | ST-01 | Q | WFR-04[c] | Q | WFR-04[c] | Q |
| **Total Metals (mg/kg)** | | | | | | | | | | | | | | | | **Dissolved Metals µg/L** | | **Total Metals µg/L** | |
| Aluminum | | 14,200 | | 11,400 | | 2,540 | | 14,900 | | 3,250 | | 40 | | Na[g] | | 47.5 | B | 58.5 | B |
| Antimony | | 0.38 | B[a] | 0.32 | U[a] | 0.32 | U | 0.32 | U | 0.32 | U | 0.32 | U | NA | | 9.4 | B | 1.6 | U |
| Arsenic | 100[d] | 9.9 | | 7.6 | | 0.41 | B | 12.1 | | 0.52 | B | 0.72 | B | NA | | 1.1 | U | 1.1 | U |
| Barium | 2,000[d] | 219 | | 161 | | 128 | | 195 | | 136 | | 113 | | NA | | 3.4 | B | 3.8 | B |
| Beryllium | | 0.86 | B | 0.72 | B | 0.32 | B | 0.93 | B | 0.48 | B | 0.31 | B | NA | | 0.90 | U | 0.90 | U |
| Cadmium | 20[d] | 0.52 | U | 0.67 | B | 0.52 | U | 0.52 | U | 0.52 | U | 0.52 | U | NA | | 2.6 | U | 2.6 | U |
| Calcium | | 4,150 | | 4,940 | | 5,780 | | 13,600 | | 8,390 | | 5,710 | | NA | | 2050 | B | 1790 | B |
| Chromium | 100[d] | 30.6 | | 22.4 | | 298 | | 26.8 | | 34.5 | | 307 | | NA | | 5.0 | U | 5.0 | U |
| Cobalt | | 8.3 | B | 6.7 | B | 1.4 | B | 8.0 | B | 2.4 | B | 1.3 | B | NA | | 4.4 | U | 4.4 | U |
| Copper | | 20.4 | | 17.2 | | 10.8 | | 29.6 | | 11.2 | | 8.5 | | NA | | 7.3 | U | 9.8 | U |
| Iron | | 20,000 | | 16,000 | | 4,240 | | 18,900 | | 5,240 | | 3,350 | | NA | | 65.3 | B | 38.9 | U |
| Lead | 100[d] | 13.6 | | 11.9 | | 9.2 | | 12.4 | | 8.5 | | 8.7 | | NA | | 1.1 | U | 1.1 | U |
| Magnesium | | 5,880 | | 4,890 | | 1,780 | | 7,220 | | 2,550 | | 1,580 | | NA | | 359 | B | 367 | B |
| Manganese | | 416 | | 430 | | 94.5 | | 374 | | 128 | | 79.9 | | NA | | 5.3 | B | 2.1 | U |
| Mercury | 4[d] | 0.05 | U | 0.05 | U | 0.05 | U | 0.05 | U | 0.05 | U | 0.05 | U | NA | | 0.10 | U | 0.10 | U |
| Nickel | | 27.6 | | 17.5 | | 4.8 | B | 26.2 | | 8.4 | | 4.6 | B | NA | | 7.9 | U | 15.4 | U |
| Potassium | | 1,390 | | 1,740 | | 1,030 | | 1,980 | | 960 | B | 662 | B | NA | | 347 | U | 1180 | U |
| Selenium | 20[d] | 0.22 | U | 0.22 | U | 0.22 | U | 0.22 | U | 0.22 | U | 0.22 | U | NA | | 1.1 | U | 1.1 | U |
| Silver | 100[d] | 1.1 | U | 1.1 | U | 1.1 | U | 1.1 | U | 1.1 | U | 1.1 | U | NA | | 5.5 | U | 5.5 | U |
| Sodium | | 275 | B | 426 | B | 1,120 | | 576 | B | 1,110 | | 690 | B | NA | | 728 | B | 397 | B |
| Thallium | | 0.37 | B | 0.22 | U | 0.22 | U | 0.22 | U | 0.22 | U | 0.22 | U | NA | | 1.1 | U | 1.1 | U |
| Vanadium | | 35.7 | | 26.4 | | 5.0 | B | 32.5 | | 7.9 | B | 5.3 | B | NA | | 15.5 | U | 15.5 | U |
| Zinc | | 50.2 | | 51.2 | | 22.7 | | 57.4 | | 26.2 | | 18.1 | | NA | | 85.6 | | 13.8 | B |

Refer to footnotes at end of table.

# Table 1-3
## Sediment Sampling Results for Rulison Drilling Effluent Pond
(Page 2 of 2)

| Compound | Regulatory Limit | Analytical Results for Sampling Conducted in April 1995 — Sediment Samples | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | SD-14 | Q[a] | SD-15 | Q | SD-16 | Q | SD-17 | Q | SD-18 | Q | SD-19[b] | Q | ST-01 | Q | WFR-04[c] | Q | WFR-04[c] | Q |
| **TCLP Metals mL** | | | | | | | | | | | | | | | | | | | |
| Arsenic | 5.0[e] | 0.035 | U | 0.035 | U | 0.035 | U | 0.035 | U | 0.035 | U | 0.035 | U | NA | | NA | | NA | |
| Barium | 100[e] | 0.76 | | 0.49 | | 0.92 | | 0.44 | | 0.88 | | 1.1 | | NA | | NA | | NA | |
| Cadmium | 1.0[e] | 0.0024 | U | 0.0024 | U | 0.0024 | U | 0.0024 | U | 0.0024 | U | 0.0024 | U | NA | | NA | | NA | |
| Chromium | 5.0[e] | 0.0080 | B | 0.0047 | U | 0.23 | | 0.0047 | U | 0.026 | | 0.17 | | NA | | NA | | NA | |
| Lead | 5.0[e] | 0.028 | U | 0.028 | U | 0.029 | B | 0.028 | U | 0.028 | U | 0.028 | U | NA | | NA | | NA | |
| Mercury | 0.2[e] | 0.00019 | B | 0.00010 | U | 0.00010 | U | 0.00010 | U | 0.00010 | U | 0.00020 | | NA | | NA | | NA | |
| Selenium | 1.0[e] | 0.038 | U | 0.038 | U | 0.38 | U | 0.038 | U | 0.038 | U | 0.038 | U | NA | | NA | | NA | |
| Silver | 5.0[e] | 0.0047 | B | 0.0041 | U | 0.0041 | U | 0.0041 | U | 0.0041 | U | 0.0041 | U | NA | | NA | | NA | |
| **TPH mg/kg** | | | | | | | | | | | | | | | | | | | |
| Diesel | [f] | NA | | NA | | NA | | NA | | NA | | NA | | 25 | U | NA | | NA | |
| Waste Oil | [f] | NA | | NA | | NA | | NA | | NA | | NA | | 25 | U | NA | | NA | |
| **BTEX mg/kg** | | | | | | | | | | | | | | | | **µg/L** | | | |
| Benzene | [h] | NA | | NA | | NA | | NA | | NA | | NA | | 2.0 | U | 2.0 | U | 2.0 | U |
| Toluene | [h] | NA | | NA | | NA | | NA | | NA | | NA | | 2.0 | U | 2.0 | U | 2.0 | U |
| Ethylbenzene | [h] | NA | | NA | | NA | | NA | | NA | | NA | | 2.0 | U | 2.0 | U | 2.0 | U |
| Xylene | [h] | NA | | NA | | NA | | NA | | NA | | NA | | 4.0 | U | 4.0 | U | 4.0 | U |

[a] Q = Laboratory assigned data qualifier: U = Compound was analyzed for but not detected; B = In organics, the analyte was found in the blank. In inorganics, the result is above the Instrument Detection Limit but below the Contract Required Detection Limit.
[b] Duplicate sample of SD-18
[c] Quality Assurance Sample
[d] No regulations for these soil parameters are specified in the Colorado Department of Health "Storage Tank Facility Owner/Operator Guidance Document." Regulatory limits are based on 20X the RCRA "Maximum Concentration of Contaminants for the Toxicity Characteristic."
[e] No regulations for these soil parameters are specified in the Colorado Department of Health "Storage Tank Facility Owner/Operator Guidance Document." Regulatory limits are based on RCRA "Maximum Concentration of Contaminants for the Toxicity Characteristic."
[f] Regulatory limits for these parameters specified in the Colorado Department of Health "Storage Tank Facility Owner/Operator Guidance Document." Regulatory limits are based on RCRA "Maximum Concentration of Contaminants for the Toxicity Characteristic."
[g] The sample was not analyzed for that parameter.
[h] No individual regulatory level for this parameter, it is combined as Total BTEX.

mg/kg = milligram per kilogram
µg/kg = microgram per kilogram
mg/L = milligram per liter
µg/L = microgram per liter

# Table 1-4
# Soil Sampling Results for Rulison Drilling Effluent Pond
(Page 1 of 3)

| Compound | Regulatory Limit | Soil Samples Collected Sept. and Oct. 1994 | | | | | | Soil Samples Collected in April 1995 | | | | | | Field Rinsate | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | SS-01 | Q[a] | SS-02 | Q | SS-03 | Q | SS-04 | Q | SS-05[b] | Q | SS-06 | Q | WFR-03[c] | Q |
| **Total Metals (mg/kg)** | | | | | | | | | | | | | | µg/L | |
| Aluminum | | 7,300 | | 6,320 | | 13,000 | | 5,940 | | 3,710 | | 11,000 | | 26.2 | B |
| Antimony | | 0.36 | U[a] | 0.36 | U | 0.45 | B[a] | 0.32 | U | 0.32 | U | 0.32 | U | 1.8 | U |
| Arsenic | 100[d] | 5.4 | | 2.4 | | 15 | | 2.6 | | 2 | B | 6.2 | | 1 | U |
| Barium | 2,000[d] | **2,530** | | **6,040** | | 206 | | **6,870** | | **5,000** | | 895 | | 2.1 | B |
| Beryllium | | 0.65 | B | 0.71 | B | 0.82 | B | 0.63 | B | 0.55 | B | 0.71 | B | 0.2 | U |
| Cadmium | 20[d] | 0.74 | U | 0.74 | U | 0.86 | B | 0.71 | B | 0.52 | U | 0.52 | U | 3.7 | U |
| Calcium | | 4,950 | | 10,600 | | 6,270 | | 6,950 | | 7,130 | | 4,640 | | 115 | B |
| Chromium | 100[d] | **467** | | **857** | | 25.5 | | **779** | | **750** | | **112** | | 3.4 | U |
| Cobalt | | 6.5 | B | 9.3 | B | 8.2 | B | 10.2 | | 7.4 | B | 7.4 | B | 3.2 | U |
| Copper | | 19.7 | | 26.1 | | 18.5 | | 23.4 | | 21.5 | | 15.2 | | 9.3 | B |
| Iron | | 12,300 | | 12,500 | | 20,200 | | 11,500 | | 9,250 | | 16,200 | | 110 | |
| Lead | 100[d] | 47.6 | | 84 | | 18.8 | | 86.3 | | 77.8 | | 18.3 | | 1 | U |
| Magnesium | | 3,230 | | 3,550 | | 6,540 | | 2,920 | | 2,220 | | 4,040 | | 113 | B |
| Manganese | | 294 | | 279 | | 445 | | 286 | | 218 | | 272 | | 1.8 | B |
| Mercury | 4[d] | 0.05 | U | 0.06 | B | 0.05 | B | 0.05 | U | 0.05 | U | 0.05 | U | 0.16 | B |
| Nickel | | 14.4 | | 11.3 | | 19.4 | | 11.5 | | 9.1 | | 16.1 | | 15.5 | U |
| Potassium | | 1,560 | | 2,400 | | 1,560 | | 1,730 | | 1,400 | | 2,260 | | 1,940 | U |
| Selenium | 20[d] | 0.26 | U | 0.26 | U | 0.26 | U | 0.22 | U | 0.22 | U | 0.22 | U | 1.3 | U |
| Silver | 100[d] | 0.74 | U | 0.74 | U | 0.74 | U | 1.1 | U | 1.1 | U | 1.1 | U | 3.7 | U |
| Sodium | | 2,020 | | 1,080 | | 774 | B | 208 | B | 279 | B | 109 | B | 250 | B |
| Thallium | | 0.3 | U | 0.3 | U | 0.33 | B | 0.22 | U | 0.22 | U | 0.22 | U | 1.5 | U |
| Vanadium | | 14.2 | | 9.4 | B | 36.3 | | 10 | | 5.9 | B | 22.3 | | 5.6 | B |
| Zinc | | 135 | | 245 | | 54.1 | | 243 | | 221 | | 67.6 | | 19.7 | B |

Refer to footnotes at end of table.

# Table 1-4
## Soil Sampling Results for Rulison Drilling Effluent Pond
(Page 2 of 3)

| Compound | Regulatory Limit | Soil Samples Collected Sept. and Oct. 1994 | | | | | | Soil Samples Collected in April 1995 | | | | | | Field Rinsate | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | SS-01 | Q[a] | SS-02 | Q | SS-03 | Q | SS-04 | Q | SS-05[b] | Q | SS-06 | Q | WFR-03[c] | Q |
| **TCLP Metals (mg/L)** | | | | | | | | | | | | | | | |
| Arsenic | 5[e] | NA[f] | | NA | | NA | | 0.035 | U | 0.035 | U | 0.035 | U | NA | |
| Barium | 10[e] | NA | | NA | | NA | | 1 | | 0.87 | | 0.62 | | NA | |
| Cadmium | 1[e] | NA | | NA | | NA | | 0.0024 | U | 0.0024 | U | 0.002 | U | NA | |
| Chromium | 5[e] | NA | | 0.22 | | NA | | 0.05 | | 0.12 | | 0.005 | B | NA | |
| Lead | 5[e] | NA | | 0.042 | U | NA | | 0.028 | U | 0.039 | B | 0.028 | U | NA | |
| Selenium | 1[e] | NA | | NA | | NA | | 0.038 | U | 0.038 | U | 0.038 | U | NA | |
| Silver | 5[e] | NA | | NA | | NA | | 0.0041 | U | 0.0041 | U | 0.004 | U | NA | |
| Mercury | 0.20[e] | NA | | NA | | NA | | 0.00010 | U | 0.00014 | B | 0.0001 | U | NA | |
| **TPH (mg/kg)** | | | | | | | | | | | | | | **ug/L** | |
| Nonspecific | 250[g] | NA | | NA | | NA | | NA | | NA | | NA | | NA | |
| Gas | | 16 | | **75** | * | 0.83 | * | NA | | NA | | NA | | 100 | U |
| Diesel | | 12,000 | | **73,000** | | 25 | U | NA | | NA | | NA | | 500 | U |
| Waste Oil | | 250 | U | 2,500 | U | 54 | | NA | | NA | | NA | | 500 | U |

Refer to footnotes at end of table.

# Table 1-4
# Soil Sampling Results for Rulison Drilling Effluent Pond
(Page 3 of 3)

| Compound | Regulatory Limit | Soil Samples Collected Sept. and Oct. 1994 | | | | | | Soil Samples Collected in April 1995 | | | | | | Field Rinsate | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | SS-01 | Q[a] | SS-02 | Q | SS-03 | Q | SS-04 | Q | SS-05[b] | Q | SS-06 | Q | WFR-03[c] | Q |
| **BTEX (μg/kg)** | | | | | | | | | | | | | | ug/L | |
| Benzene | h | 4.9 | | 38 | | 2 | U | NA | | NA | | NA | | NA | |
| Toluene | h | 17 | | 570 | | 2 | U | NA | | NA | | NA | | NA | |
| Ethylbenzene | h | 120 | | 570 | | 2 | U | NA | | NA | | NA | | NA | |
| Xylene | h | 500 | | 2,800 | | 2 | U | NA | | NA | | NA | | NA | |
| Total BTEX | 50,000 | 641.9 | | 3,978 | | 2 | U | NA | | NA | | NA | | NA | |

[a] Q = Laboratory assigned data qualifier: U = Compound was analyzed but not detected; B = In organics, the analyte was found in the blank. In inorganics, the result is above the Instrument Detection Limit but below the Contract Required Detection Limit.
[b] Duplicate of Sample SS-04
[c] Field Rinsate taken during October 1994 sampling event
[d] No regulations for these soil parameters are specified in the Colorado Department of Health "Storage Tank Facility Owner/Operator Guidance Document." Regulatory limits are based on 20X RCRA Maximum Concentration of Contaminants for the Toxicity Characteristic."
[e] No regulations for these soil parameters are specified in the Colorado Department of Health "Storage Tank Facility Owner/Operator Guidance Document." Regulatory limits are based on RCRA Maximum Concentration of Contaminants for the Toxicity Characteristic."
[f] The sample was not analyzed for that parameter.
[g] This limit is based on regulations specified in the Colorado Department of Health "Storage Tank Facility Owner/Operator Guidance Document."
[h] No individual regulatory level for this parameter, it is combined as Total BTEX.

* Value outside of QA limits

mg/kg = milligram per kilogram  μg/kg = microgram per kilogram
mg/L = milligram per liter  μg/L = microgram per liter

## Table 1-5
## Surface Water Sampling Results for Rulison Drilling Effluent Pond
(Page 1 of 2)

| Compound | Regulatory Limit[a] | Sampling Conducted in Sept. and Oct. 1994 — Pond Surface Water Samples | | | | | | | | Sampling Conducted in April 1995 — Stream | | Spring | | Stream | | Spring | | Sampling Conducted in April 1995 — Pond Surface Water Samples | | | | | | | | October 1994 — Rinsate Samples | | April 1995 — Rinsate Samples | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | SW-01 | Q[b] | SW-02 | Q | SW-03 | Q | SW-04 | Q | SWST-01 | Q | SWS-01 | Q | SWST-01 | Q | SWS-01 | Q | SWP-01 | Q | SWP-02 | Q | SWP-03* | Q | SWP-04 | Q | WFR-01 | Q | WF-04 | Q |
| **Total Metals (µg/l)** | | | | | | | | | | **Total Metals (µg/l)** | | | | **Dissolved Metals (µg/l)** | | | | | | | | | | | | | | | |
| Aluminum | | 52.4 | B[b] | 135 | B | 43.2 | B | 77.2 | B | 228 | | 32.5 | U | 34.1 | B | 55.6 | B | NA[c] | | NA | | NA | | NA | | 27.5 | B | NA | |
| Antimony | | 1.8 | U[b] | 1.8 | U | 1.8 | U | 1.8 | U | 1.6 | U | 3.3 | B | 3.2 | B | 6 | B | NA | | NA | | NA | | NA | | 1.8 | U | NA | |
| Arsenic | 50 | 7.4 | B | 7.5 | B | 7 | B | 7.4 | B | 1.3 | B | 1.1 | U | 1.1 | U | 1.1 | U | NA | | NA | | NA | | NA | | 1 | U | NA | |
| Barium | 1,000 | 51.2 | B | 52.8 | B | 49.8 | B | 51.9 | B | 52.8 | B | 46.4 | B | 47.9 | B | 45.8 | B | NA | | NA | | NA | | NA | | 1.8 | B | NA | |
| Beryllium | | 0.86 | B | 0.29 | B | 0.29 | B | 0.29 | B | 1.7 | B | 0.9 | U | 0.9 | U | 1.4 | B | NA | | NA | | NA | | NA | | 0.21 | B | NA | |
| Cadmium | 10 | 3.7 | U | 3.7 | U | 3.7 | U | 3.7 | U | 2.6 | B | 2.6 | U | 2.6 | U | 2.6 | U | NA | | NA | | NA | | NA | | 3.7 | U | NA | |
| Calcium | | 23,400 | | 23,800 | | 22,900 | | 23,500 | | 43,300 | | 83,100 | | 42,600 | | 82,000 | | NA | | NA | | NA | | NA | | 90.4 | B | NA | |
| Chromium | 50 | 3.4 | U | 3.4 | U | 3.4 | U | 3.9 | B | 5 | U | 5 | U | 5 | U | 5 | U | NA | | NA | | NA | | NA | | 3.4 | U | NA | |
| Cobalt | | 3.2 | U | 3.2 | U | 3.2 | U | 3.2 | U | 4.4 | U | 4.4 | U | 4.4 | U | 4.4 | U | NA | | NA | | NA | | NA | | 3.2 | U | NA | |
| Copper | | 10.7 | B | 12.5 | B | 8.5 | B | 16.9 | B | 10.6 | B | 9.8 | U | 7.3 | U | 8.8 | B | NA | | NA | | NA | | NA | | 9.3 | B | NA | |
| Iron | | 62.2 | B | 201 | | 61 | B | 177 | | 239 | | 38.9 | U | 38.9 | U | 38.9 | U | NA | | NA | | NA | | NA | | 46 | B | NA | |
| Lead | 50 | 1 | U | 1 | U | 1 | U | 1 | U | 1.1 | U | 1.1 | U | 1.1 | U | 1.1 | U | NA | | NA | | NA | | NA | | 1 | U | NA | |
| Magnesium | | 28,900 | | 29,200 | | 28,700 | | 29,400 | | 15,300 | | 58,100 | | 15,200 | | 56,400 | | NA | | NA | | NA | | NA | | 135 | B | NA | |
| Manganese | | 6 | B | 18.9 | | 5.5 | B | 8.3 | B | 12.9 | B | 2.1 | U | 2.7 | B | 2.1 | U | NA | | NA | | NA | | NA | | 2.9 | B | NA | |
| Mercury | 2 | 0.14 | B | 0.16 | B | 0.16 | B | 0.16 | B | 0.1 | U | 0.1 | U | 0.1 | U | 0.1 | U | NA | | NA | | NA | | NA | | 0.16 | B | NA | |
| Nickel | | 15.5 | U | 15.5 | U | 15.5 | U | 15.5 | U | 15.4 | U | 15.4 | U | 7.9 | U | 7.9 | U | NA | | NA | | NA | | NA | | 15.5 | U | NA | |
| Potassium | | 2,030 | B | 1,940 | U | 1,940 | U | 1,940 | U | 1,860 | B | 1,180 | U | 1,890 | B | 1,240 | B | NA | | NA | | NA | | NA | | 1,940 | U | NA | |
| Selenium | 10 | 6.5 | U | 6.5 | U | 6.5 | U | 6.5 | U | 1.5 | B | 2.1 | B | 1.1 | U | 2.7 | B | NA | | NA | | NA | | NA | | 1.3 | U | NA | |
| Silver | 50 | 3.7 | U | 3.7 | U | 3.7 | U | 3.7 | U | 5.5 | U | 5.5 | U | 5.5 | U | 5.5 | U | NA | | NA | | NA | | NA | | 3.7 | U | NA | |
| Sodium | | 51,400 | | 52,500 | | 51,700 | | 52,300 | | 18,900 | | 52,800 | | 19,900 | | 50,600 | | NA | | NA | | NA | | NA | | 183 | B | NA | |
| Thallium | | 1.5 | U | 1.5 | U | 1.5 | U | 1.5 | U | 1.1 | U | 1.1 | U | 1.1 | U | 1.1 | U | NA | | NA | | NA | | NA | | 1.5 | U | NA | |
| Vanadium | | 11 | B | 11 | B | 9.7 | B | 10.5 | B | 15.5 | U | 15.5 | U | 15.5 | U | 15.5 | U | NA | | NA | | NA | | NA | | 4 | B | NA | |
| Zinc | | 9.4 | B | 14.2 | B | 11.1 | B | 11.3 | B | 13.2 | B | 10.3 | B | 10.2 | B | 9.6 | B | NA | | NA | | NA | | NA | | 7.3 | B | NA | |
| **TPH[d] (mg/l)** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Nonspecific | | 0.48 | U | 0.51 | U | 0.48 | U | 0.56 | U | NA | | NA | | NA | | NA | | NA | | NA | | NA | | NA | | 0.49 | U | NA | |
| Gas | | NA | | NA | | NA | | NA | | NA | | NA | | NA | | NA | | NA | | NA | | NA | | NA | | NA | | NA | |
| Diesel | | NA | | NA | | NA | | NA | | NA | | NA | | NA | | NA | | NA | | NA | | NA | | NA | | NA | | NA | |
| Waste Oil | | NA | | NA | | NA | | NA | | NA | | NA | | NA | | NA | | NA | | NA | | NA | | NA | | NA | | NA | |

Refer to footnotes at end of table.

## Table 1-5
## Surface Water Sampling Results for Rulison Drilling Effluent Pond
(Page 2 of 2)

| Compound | Regulatory Limit[a] | Sampling Conducted in Sept. and Oct. 1994 — Pond Surface Water Samples | | | | | | | | Sampling Conducted in April 1995 — Stream | | Spring | | Stream | | Spring | | Sampling Conducted in April 1995 — Pond Surface Water Samples | | | | | | | | October 1994 — Rinsate Samples | | April 1995 — Rinsate Samples | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | SW-01 | Q[b] | SW-02 | Q | SW-03 | Q | SW-04 | Q | SWST-01 | Q | SWS-01 | Q | SWST-01 | Q | SWS-01 | Q | SWP-01 | Q | SWP-02 | Q | SWP-03* | Q | SWP-04 | Q | WFR-01 | Q | WF-04 | Q |
| **Tritium (pCi/ℓ)** | | | | | | | | | | | | | | ** | ** | ** | ** | | | | | | | | | | | | |
| Tritium | | -2 | | 40 | | 78 | | 70 | | NA | | NA | | ** | ** | ** | ** | NA | | NA | | NA | | NA | | -2 | | NA | |
| 2 Sigma Error (+/-) | | 103 | | 105 | | 106 | | 106 | | NA | | NA | | ** | ** | ** | ** | NA | | NA | | NA | | NA | | 103 | | NA | |
| MDA | | 178 | | 178 | | 178 | | 178 | | NA | | NA | | ** | ** | ** | ** | NA | | NA | | NA | | NA | | 178 | | NA | |
| **BTEX[e] (ug/kg)** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Benzene | 5[f] | NA | | NA | | NA | | NA | | 2 | U | 2 | U | ** | ** | ** | ** | 2 | U | 2 | U | 2 | U | 2 | U | NA | | 2 | U |
| Toluene | 1,000 | NA | | NA | | NA | | NA | | 2 | U | 2 | U | ** | ** | ** | ** | 2 | U | 2 | U | 2 | U | 2 | U | NA | | 2 | U |
| Ethylbenzene | 680 | NA | | NA | | NA | | NA | | 2 | U | 2 | U | ** | ** | ** | ** | 2 | U | 2 | U | 2 | U | 2 | U | NA | | 2 | U |
| Xylene | 10,000 | NA | | NA | | NA | | NA | | 4 | U | 4 | U | ** | ** | ** | ** | 4 | U | 4 | U | 4 | U | 4 | U | NA | | 4 | U |

[a]No regulations for metal concentrations, Total Petroleum Hydrocarbon and Radionuclides are specified in the Colorado Department of Health "Storage Tank Facility Owner/Operator Guidance Document." Colorado water clean-up standards are site specific and based on "The Basic Standards for Groundwater (5CCR1002-8)." The Safe Drinking Water Standards have been provided for comparison purposes only.
[b]Q = Laboratory assigned data qualifier: U = Compound was analyzed for but not detected; B = In inorganics, the result is above the Instrument Detection Limit but below the Contract Required Detection Limit.
[c]The sample was not analyzed for that pararmeter.
[d]Total Petroleum Hydrocarbons
[e]Benzene, Toluene, Ethylbenzene, Xylene
[f]This limit is based on regulation specified in the Colorado Department of Health "Storage Tank Facility Owner/Operator Guidance Documents."

*Duplicate of sample SWP-02
**These samples were not analyzed for these parameters.

mg/kg = milligram per kilogram
µg/kg = microgram per kilogram
µg/ℓ = microgram per liter

# Table 1-6
# Fish Sampling Results for Rulison Drilling Effluent Pond

| Compound | Sampling Conducted in September and October 1994 | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | F-01 | Q[a] | F-02 | Q | F-03 | Q | WFB-01[b] | Q |
| **Metals (mg/kg)** | | | | | | | mg/L | |
| Aluminum | 6.40 | B[a] | 5 | U[a] | 5 | U | 59.9 | B |
| Antimony | 0.36 | U | 0.36 | U | 0.36 | U | 1.8 | U |
| Arsenic | 0.26 | U | 0.26 | U | 0.43 | B | 1.0 | U |
| Barium | 0.31 | B | 0.21 | B | 0.16 | B | 1.4 | B |
| Beryllium | 0.04 | B | 0.04 | U | 0.04 | U | 0.29 | B |
| Cadmium | 0.74 | U | 0.74 | U | 0.74 | U | 3.7 | U |
| Calcium | 369 | B | 426 | B | 453 | B | 69.2 | B |
| Chromium | 0.68 | U | 0.68 | U | 0.68 | U | 3.4 | U |
| Cobalt | 0.64 | U | 0.64 | U | 0.64 | U | 3.2 | U |
| Copper | 0.77 | B | 0.5 | U | 0.5 | U | 8.4 | B |
| Iron | 12.6 | B | 11.1 | B | 5.7 | B | 71.0 | B |
| Lead | 0.2 | U | 2 | U | 2 | U | 1.0 | U |
| Magnesium | 259 | B | 233 | B | 284 | B | 155 | B |
| Manganese | 0.14 | U | 0.14 | B | 0.14 | U | 1.7 | B |
| Mercury | 0.13 | | 0.05 | B | 0.08 | B | 0.15 | B |
| Nickel | 3.1 | U | 3.1 | U | 3.1 | U | 15.5 | U |
| Potassium | 4,870 | | 3,880 | | 4,490 | | 1,940 | U |
| Selenium | 0.26 | U | 0.26 | U | 0.26 | U | 1.3 | U |
| Silver | 0.74 | U | 0.74 | U | 0.74 | U | 3.7 | U |
| Sodium | 609 | B | 693 | B | 780 | B | 168 | B |
| Sodium | 0.3 | U | 0.3 | U | 0.3 | U | 1.5 | U |
| Vanadium | 0.62 | U | 0.62 | U | 0.62 | U | 4.9 | B |
| Zinc | 6.2 | | 6.3 | | 9.1 | | 13.5 | B |
| **TPH (mg/kg)[c]** | | | | | | | | |
| Nonspecific | 13.7 | | 31.5 | | 17.3 | | 0.49 | U |
| Gas | NA[d] | | NA | | NA | | NA | |
| Diesel | NA | | NA | | NA | | NA | |
| Waste Oil | NA | | NA | | NA | | NA | |

[a]Q = Laboratory assigned data qualifier: U = Compound was analyzed for but not detected; B = In inorganics, the result is above the Instrument Detection Limit but below the Contract Required Detection Limit.
[b]Field blank sample
[c]Total Petroleum Hydrocarbons
[d]The sample was not analyzed for that parameter.

mg/kg = milligram per kilogram
mg/L = milligram per liter

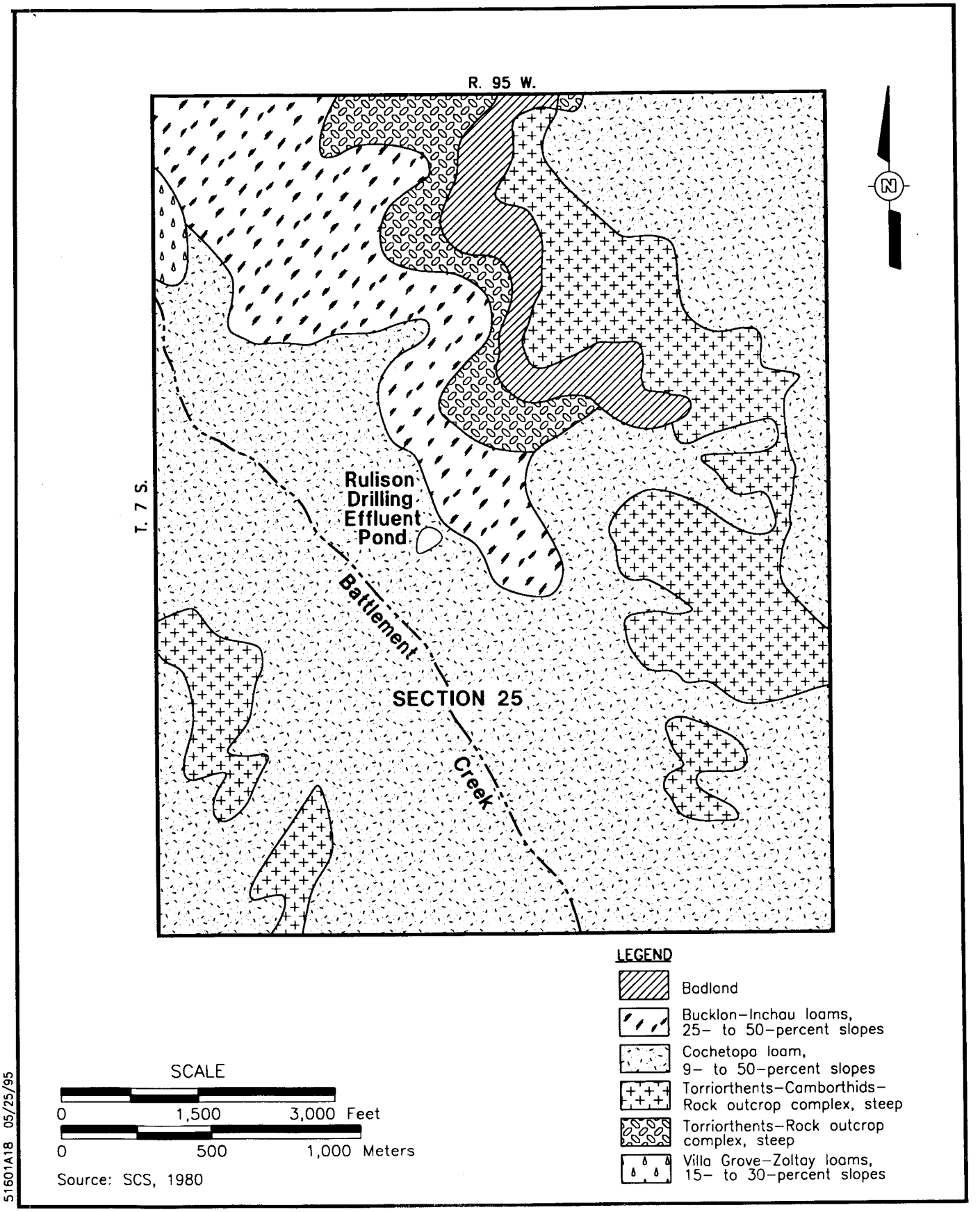


**Figure 1-2**
**Soil Conservation Service Soils Map**
**Rifle Area, Colorado-Rulison Project**

Two soil mapping units have been identified within the 40 acres surrounding the effluent-pond location. These are the Bucklon-Inchau loams, found on 25- to 50-percent slopes, and Cochetopa loam, found on 9- to 50-percent slopes (SCS, 1980) (Figure 1-2). The characteristics of these soils were confirmed by field analysis of numerous soil borings conducted during the wetlands and floodplain investigation performed in June 1993 (IT, 1993).

The drilling-effluent pond was constructed in the Cochetopa loam. According to the U.S. Soil Conservation Service (SCS) general description for this type of soil, the Cochetopa loam is deep and well drained and is found on rolling to steep mountainsides and alluvial fans. The subsoil below approximately 0.2 m (24 inches) consists of stony clay with a low permeability. Surface runoff is slow, the erosion hazard is categorized as severe and shrink-swell potential is high. High clay content in the soil causes low soil strength and a high potential for soil slumping.

### *1.5.2 Site Hydrology*

#### *1.5.2.1 Surface Water*

Battlement Creek and its tributaries provide the main control over surface waters at the Rulison Site. The Creek and the tributaries flow in a northwesterly direction toward the Colorado River. An unnamed tributary transects the Rulison Site and is adjacent to the effluent pond (Figure 1-3). Approximately 30 m (100 ft) below the effluent pond, this tributary flows into a series of beaver ponds (Figure 1-4). Battlement Creek and its tributaries are generally confined to relatively narrow stream channels, except for the beaver pond area where the tributary channel widens.

Several springs are present in the general area of the drilling-effluent pond. The visible source of water for the pond is from snow melt and from a spring, located southeast of the pond approximately 100 m (305 ft), that replenishes the pond by surface flow via an inlet in the northern berm. The pond also has an overflow outlet in the western berm although the water level in the pond is seldom high enough for overflow to occur.

The amount of surface runoff is unknown; however, because of the high clay content in site soils, the SCS reports surface runoff velocity is slow and the potential for erosion is severe. However, it is likely during spring melt, after the soil profile becomes saturated, surface runoff from snow melt is quite substantial.

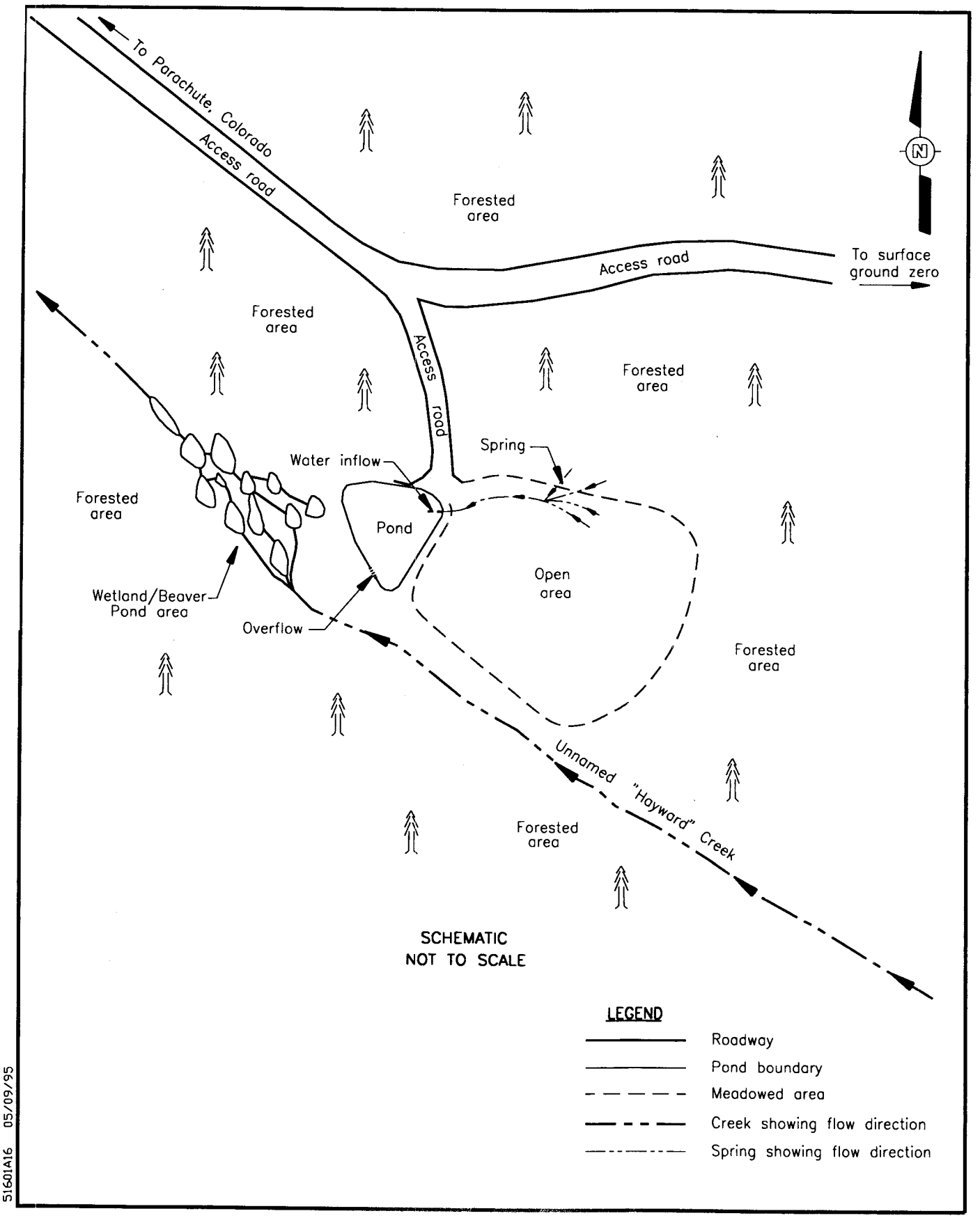


**Figure 1-3**
**General Site Layout Diagram**
**Rulison Drilling Effluent Pond**

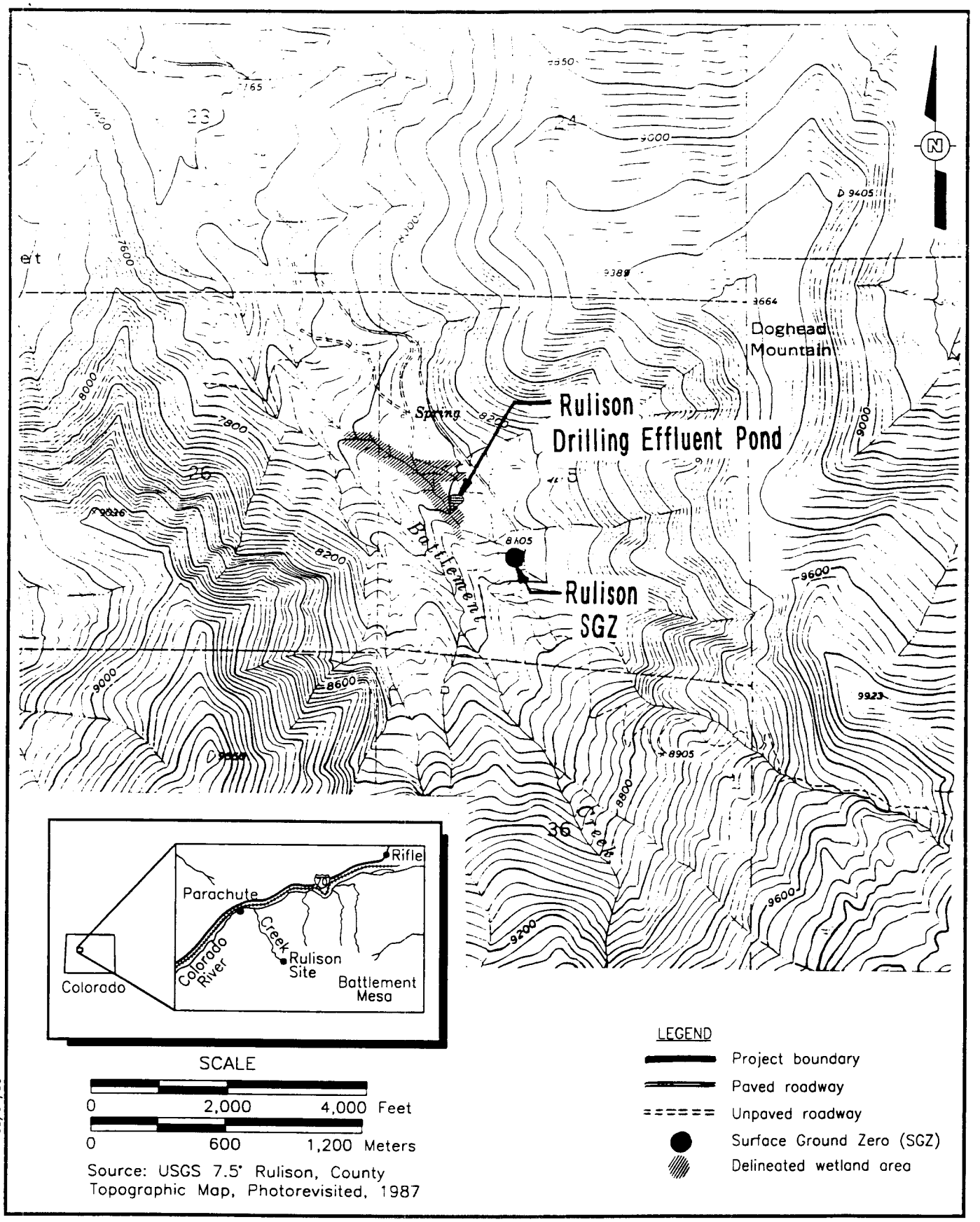


**Figure 1-4**
**Topographic Map Project Rulison with Delineated Wetland Areas**

#### 1.5.2.2 Groundwater

Very little site-specific information is available regarding the nature of groundwater at the Rulison Drilling-Effluent Pond Site. Based on regional information, groundwater may be located approximately 9 to 12 m (30 to 40 ft) BGS. However, several lines of evidence indicate that groundwater at the Rulison Site may actually be encountered at depths ranging from 0 to 3 m (0 to 10 ft) BGS, depending on the season.

Interviews with on-site personnel present when the pond was constructed speculate that the pond was built on a spring, although it is unknown if this is true. Other indications are that the pond was actually built below the local water table. Further verbal reports by personnel present when the site was decommissioned indicate that groundwater entered the pond faster than it could be removed. In addition, the local surface expression of groundwater (springs) proximal to the Rulison Drilling-Effluent Pond Site indicates that the depth to groundwater may be less than what would be expected based on regional information.

Finally, the pond water level has remained stable for 26 years, and only seasonal elevation changes have been observed, indicating that recharge to and discharge from the pond have reached equilibrium with local groundwater environment. The water level in the pond ranges from approximately 1 to 3 m (3 to 10 ft) below the pond berm.

Based on this evidence and an inspection of the site hydrology conducted on April 19 and 20, 1995, groundwater at the effluent pond is anticipated to be at a relatively shallow depth following the natural topographic slope. At the south end (hydraulically upgradient) of the pond, the water surface is anticipated to be equivalent to the groundwater surface. At the northern, hydraulically downgradient end of the pond, the water surface is anticipated to be perched above the groundwater surface because of the damming action of the pond berm.

The groundwater flow direction at the Rulison Site is expected to follow surface topography and flow in a northwesterly direction; however, local variations may be present. The rate of groundwater flow is unknown; but, based on the known nature of the site soils, the groundwater flow rate is anticipated to be slow.

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# 2.0 Groundwater Monitoring Objectives

The objective of groundwater monitoring at the effluent-pond site is to demonstrate that the network of groundwater monitoring wells surrounding the site will detect groundwater contamination by comparing hydraulically downgradient wells with background or hydraulically upgradient wells. The frequency of groundwater sampling and the required analytes will be in compliance with the requirements specified in Appendix B, Sections B3 and B4 of 6 CCR 1007-2. Samples will be collected according to approved contractor procedures and analyzed according to methods specified in the Rulison Quality Assurance Project Plan (QAPP) (DOE, 1995b).

## 2.1 Monitoring Well Design and Site Layout

### 2.1.1 Monitoring Well Location

Eight groundwater monitoring wells are planned for installation at the Rulison Drilling-Effluent Pond Site. Two of these wells will be installed hydraulically upgradient of the effluent pond, and four will be installed hydraulically downgradient of the pond. Two additional wells will be installed hydraulically downgradient of the abandoned nuclear device Emplacement Hole R-E. Figure 2-1 is a diagram of the site layout and proposed monitoring well locations.

### 2.1.2 Groundwater Monitoring Well Installation

Groundwater monitoring wells will be installed at the Rulison Site in accordance with the Colorado Department of Natural Resources, Division of Water Resources, Regulation 2 CCR 402-2, "The Rules and Regulations for Well Construction and Pump Installation Applying to the Construction of Water Wells, Test Holes, Monitoring and Observations Wells, Dewatering Wells and the Installation of Pumping Equipment into Such Wells" (1995), and in accordance with procedures specified in the U.S. Environmental Protection Agency (EPA) guidance document *Handbook of Suggested Practices for the Design and Installation of Groundwater Monitoring Wells* (1991). The purpose of these wells will be to acquire water-level information, characterize groundwater geochemistry, and collect hydraulic aquifer information.

The monitoring-well specifications and installation procedures are presented as specified in 6 CCR 1007-2, Section B2 (B,C), "Groundwater Monitoring Systems," and 6 CCR 1007-2, Section B3, "Groundwater Sampling and Analysis Requirements."

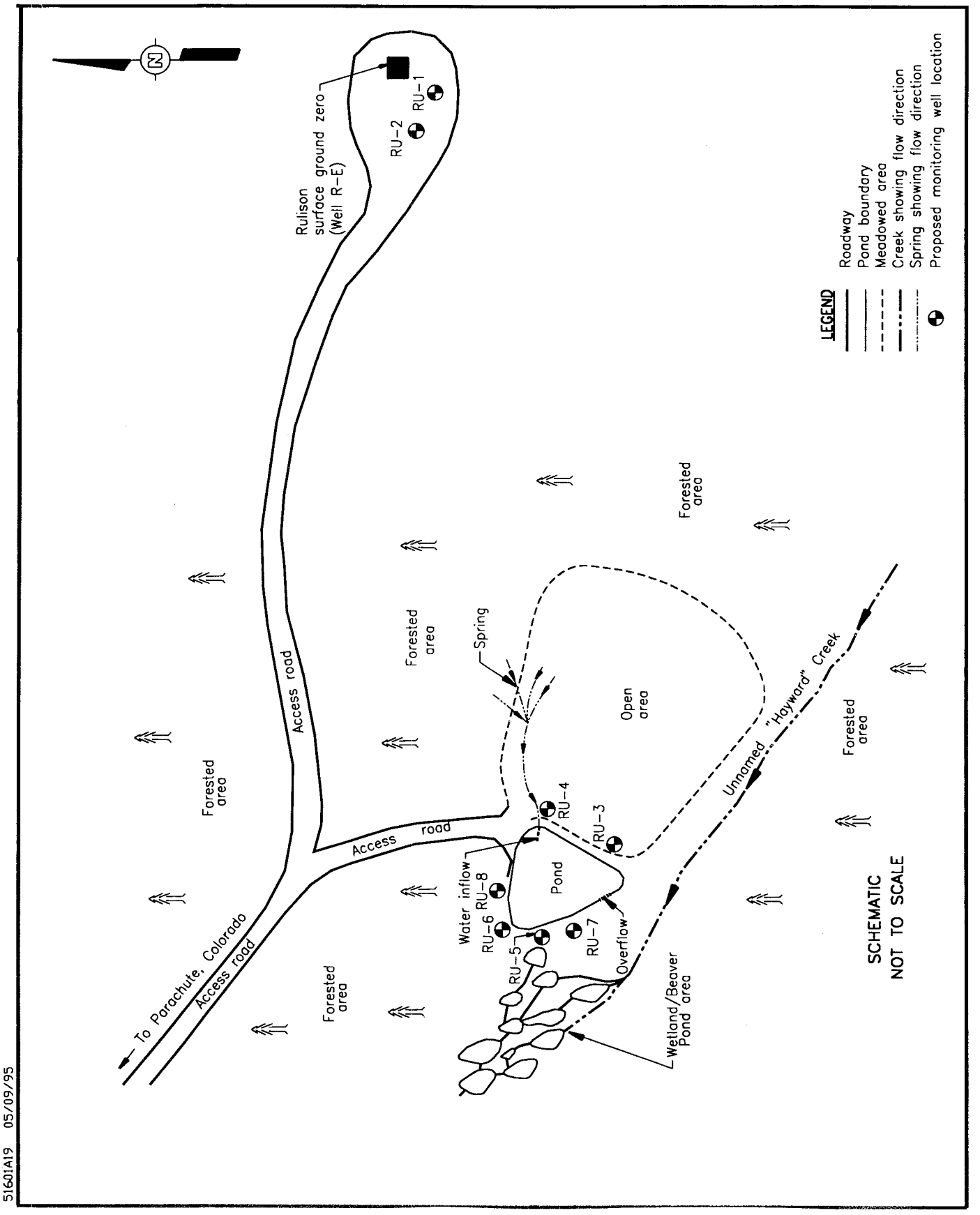


**Figure 2-1**
**Proposed Groundwater Monitoring Well Locations,**
**Rulison Drilling Effluent Pond**

## 2.2 Monitoring Well Design and Construction

Two methods will be utilized to install monitoring wells at the Rulison Drilling-Effluent Pond Site. The upgradient wells and the wells adjacent to the Emplacement Well R-E will be installed by a licensed Colorado well driller using hollow-stem auger or rotary drilling techniques. The downgradient wells, because of their location near the beaver pond area, will be installed using a hand auger or portable motorized auger, depending on the nature of shallow soils. Proposed well-construction diagrams are shown on Figures 2-2 and 2-3.

The drill rig and equipment and the well materials shall be decontaminated prior to use, using a high-pressure hot washer. Hand-auguring equipment shall be decontaminated in accordance with approved contractor procedures.

The upgradient wells will be constructed of 4-inch (in.) Schedule 80 polyvinyl chloride (PVC) casing, and the downgradient wells will be constructed of 2-in. Schedule 40 PVC casing. The type and length of the well screen will depend on actual hydrologic conditions encountered in the field; however, it is expected that the upgradient wells will use 13.7 m (45 ft) of 0.020-in. slot screen, and the downgradient wells will use approximately 2 m (7 ft) of 0.020-in. screen. The wells downgradient of Emplacement Well R-E will use approximately 13.7 m (45 ft) of 0.020-in. screen.

Depending on the depth to water encountered during drilling, the well screens for the wells placed on the periphery of the drilling-effluent pond will be placed as close as possible to intersect the water table and the unsaturated zone above the water table. The well screens will be placed approximately 6 m (20 ft) BGS at the wells adjacent to Emplacement Well R-E. Centralizers spaced at 7.6-m (25-ft) intervals will be used in the 4-in. wells.

Well casings will extend approximately 1 m (3 ft) above the ground surface. Protective surface monuments will be installed around the two upgradient wells and at the wells adjacent to Emplacement Well R-E. Each monument will consist of a protective steel casing that extends to approximately 0.9 m (30 in.) BGS. Each steel casing will have a locking cover and be vented at the top and base for drainage. Steel casings will be installed into a concrete apron with four steel posts at the corners for protection at each of the 4-in. wells. Because of their location, the 2-in. wells will only use steel casings anchored into concrete with locking covers for protection.

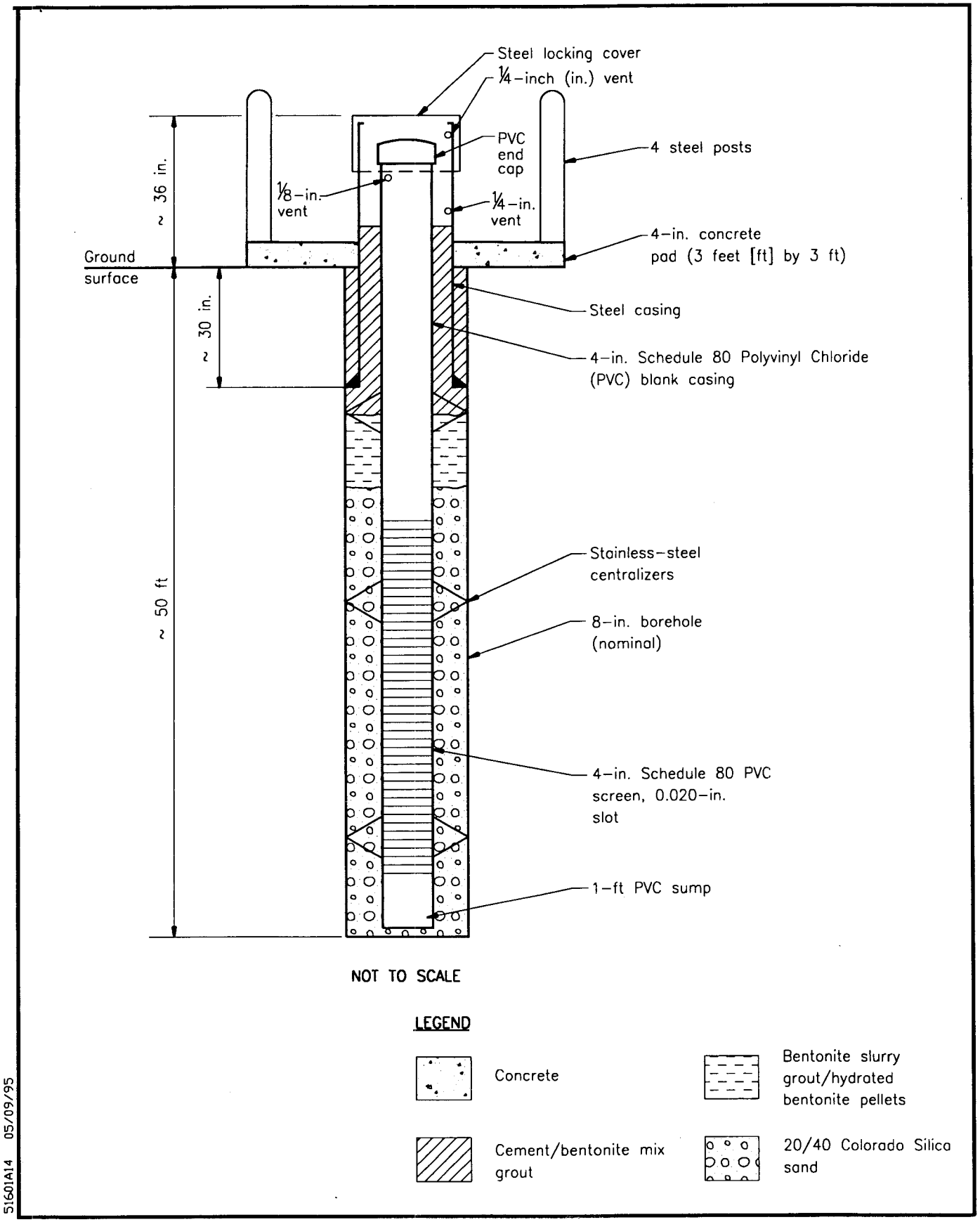


**Figure 2-2**
**Rulison Drilling Effluent Pond**
**Schematic Well Construction Diagram**

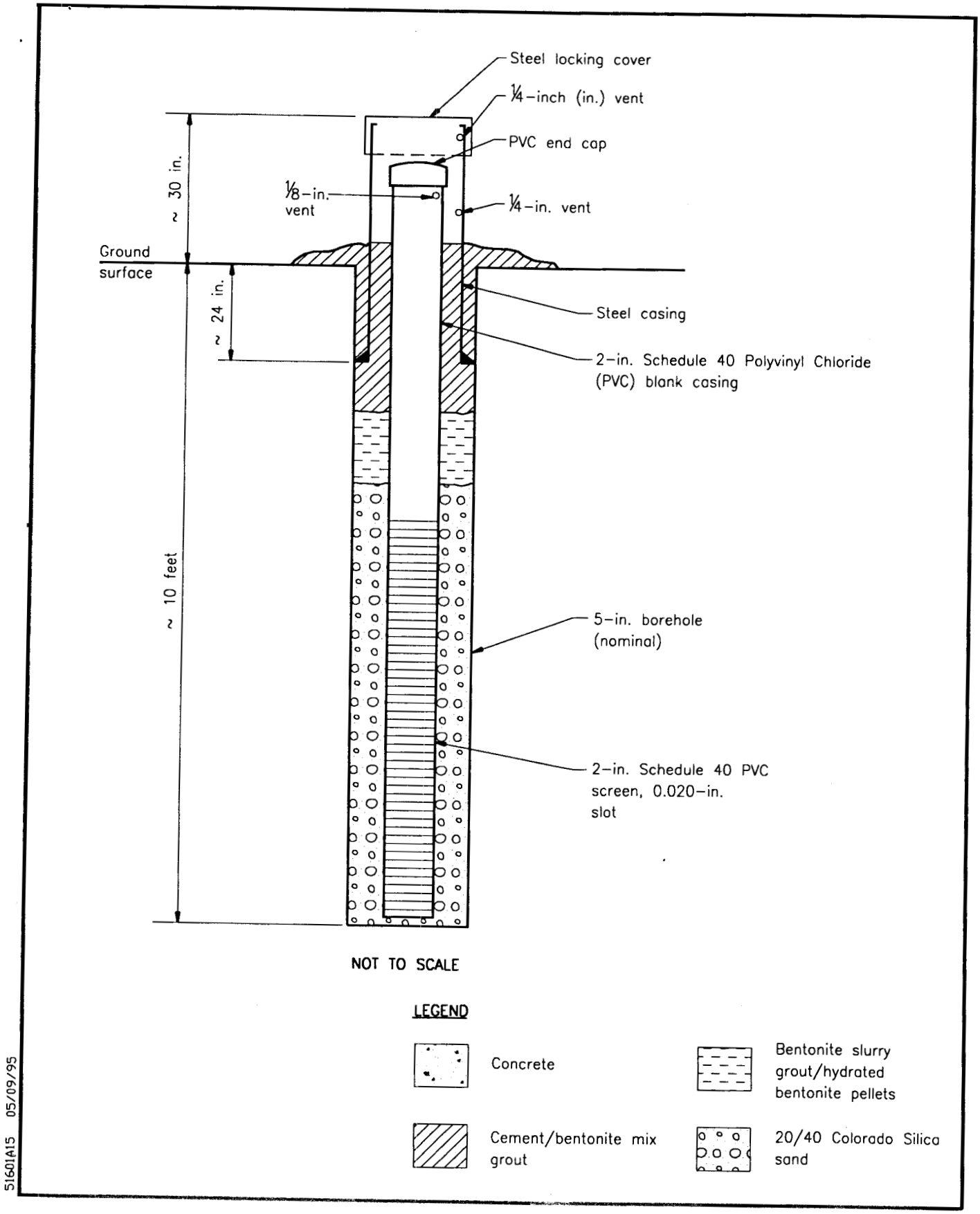


**Figure 2-3**
**Rulison Drilling Effluent Pond**
**Schematic Well Construction Diagram, Hand-Installed Wells**

The wells will contain filter packs consisting of washed and graded silica sand that is appropriate for the formation and slot size of the well screens. A filter pack size of 20/40 is expected to be appropriate for the soils around the effluent pond. Either a bentonite slurry or hydrated bentonite pellets will be used for a seal above the filter pack, depending on the depth to groundwater and the top of the well screen. Above the bentonite seal, a cement and bentonite mix will be installed to the ground surface.

### 2.3 Monitoring Well Development

The newly installed groundwater monitoring wells will be developed to mitigate possible effects to the aquifer caused by drilling operations. The development activity is intended to restore the natural water quality and hydraulic parameters in the formation adjacent to the well screen. The development process maximizes the specific capacity of the well and allows the production of sand-free samples.

After the cement and bentonite surface grout has hardened, well development will be conducted by bailing, surging, pumping or a combination of these. Development will continue until the produced water is sand-free, turbidity is reduced, and pH, specific conductance, and temperature have stabilized such that three separate readings of these indicators agree within 10 percent.

### 2.4 Handling of Produced Solids and Fluids

Drill cuttings, waste materials from soil samples and fluids produced during drilling, decontamination, well development and sampling will be containerized in 55-gallon drums on site. The drums will be labeled using indelible markers with the sequential drum identification number, boring number, project number, date filled, footage filled (if appropriate), matrix material, organization name, contact person and telephone number. All drums will be secured for proper management and disposed after the analytical results from the sampling are available.

### 2.5 Aquifer Testing

Aquifer testing will be required to obtain hydraulic properties of the aquifer at the pond site. Depending upon the hydraulic conductivity of the site soils, testing may be performed by using an *in situ* method such as a slug test or by a pumping test. The collected data will be used for identification and evaluation of the hydraulic properties, including groundwater flow direction, flow rate, and hydraulic conductivity of the aquifer material.

# 3.0 Groundwater Monitoring Methodology

## 3.1 Sampling Notification

The Environmental Services Support Contractor (ESSC) Project Manager shall verbally notify the individuals granting authorization for sampling prior to activities. A Site-Specific Health and Safety Plan (SSHASP) shall be prepared and approved and all sampling activities will be conducted in accordance with an approved SSHASP.

## 3.2 Groundwater Elevation Measurement

Before purging and sampling activity at each well, the depth to groundwater and total depth of the well shall be measured. This information will be used to calculate the purge volume and evaluate any potential changes to groundwater flow direction since the previous sampling event. All depth-to-water measurements shall be performed in accordance with approved contractor procedures.

## 3.3 Well Purging

Monitoring wells will be purged of stagnant groundwater using an appropriate method based on the amount of purge water to be removed. Well purging shall be performed in accordance with approved contractor procedures. Purged water will be containerized in secured 55-gallon steel drums and disposed in accordance with applicable Colorado regulations.

## 3.4 Sample Collection

Groundwater samples will be collected from all wells with a disposable bottom-emptying bailer or another appropriate device in accordance with approved contractor procedures. For quality control (QC) purposes, one duplicate sample, one matrix spike and matrix spike duplicate sample (MS/MSD), and one equipment rinsate sample will be collected during each sampling event, as specified in Section 6.0. In addition, a trip blank shall accompany all volatile organic samples. All samples will be collected in containers and preserved as specified in Table 3-1.

## 3.5 Sample Handling and Analysis

The groundwater samples shall be analyzed for the parameters specified in Table 3-1. These parameters include those contaminants of concern (COC) identified in the drilling effluent pond sediments prior to remediaton in conjunction with the analyses required in Appendix IA of the state of Colorado Solid Waste Regulations, 6 CCR 1007-2, Appendix B, Section B4 (A). It is expected that the remediation effort will have no effect on site groundwater.

## Table 3-1
## Long-Term Groundwater Monitoring Program
## Rulison Drilling Effluent Pond
## Sample Analyses, Containers, Preservation, and Holding-Time Requirements

| Parameter | Medium | Sample Container | Minimum Amount of Sample Required | Holding Time[a] | Preservative |
|---|---|---|---|---|---|
| BTEX[b] | Water | Glass with Teflon-™ lined cap | 2 x 40 mℓ[c] | 14 days | pH <2 with HCl[d] Cool to 4°C |
| TPH[e] (diesel fraction) | Water | G[f] | 1 Liter | 14 days | pH <2 with $H_2SO_4$[g], Cool to 4°C |
| RCRA[h] Metals | Water | G or PE[i] | 1,000 mℓ | 180 days | $HNO_3$[j] to pH <2 Cool to 4°C |
| pH | Water | PE or G | 25 mℓ | Analyze Immediately | None |
| Total Dissolved Solids | Water | PE or G | 100 mℓ | 7 days | Cool to 4°C |
| Total Suspended Solids | Water | PE or G | 100 mℓ | 7 days | Cool to 4°C |
| Gross Alpha/Beta | Water | PE | 500 mℓs | 180 days | $HNO_3$ to pH <2 |
| Tritium | Water | PE or G | 100 mℓs | 180 days | None |
| Radium-226 | Water | PE or G | 1,000 mℓ | 180 days | $HNO_3$ to pH <2 |
| Gamma Spectroscopy (incl. Cesium-137) | Water | PE or G | 1,000 mℓ | 180 days | $HNO_3$ to pH <2 |
| Strontium-89, 90 | Water | PE or G | 1,000 mℓ | 180 days | $HNO_3$ to pH <2 |

[a] Holding time calculated from verified time of sample collection. Holding time for mercury is 28 days.
[b] Benzene, toulene, ethylbenzene, xylene
[c] Milliliter
[d] Hydrochloric acid
[e] Total Petroleum Hydrocarbon
[f] Glass
[g] Sulfuric acid
[h] Resource Conservation and Recovery Act
[i] Polyethylene
[j] Nitric acid

The organic and metal analyses will be performed on samples collected from the wells hydraulically upgradient and downgradient of the drilling-effluent pond. The water samples collected from the wells adjacent to the abandoned Emplacement Hole R-E will be analyzed for radiological parameters. These parameters are the same as those conducted annually for the EPA Long-Term Hydrologic Monitoring Program (EPA, 1979).

# 4.0 Reporting of Results

Upon completion of each sampling event and receipt of analytical data results, a summary report shall be prepared and submitted to the state of Colorado. This report shall contain the following information:

- The date of sampling event and site weather conditions.
- A description or discussion of unusual observations, changes or problems during sampling, and personnel present.
- A presentation of groundwater elevation and flow direction data.
- A presentation of the analytical results for each event.
- A discussion of the results, including statistical methodology used and a comparison of the analytical results with previous sampling events. The statistical analysis shall comply with the methodology and rationale presented in 6 CCR 1007-2, Appendix B, Section B3 (G).

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# 5.0 Groundwater Monitoring Schedule

Groundwater monitoring activities will begin following completion of the pond remediation. All eight monitoring wells will be sampled on a quarterly basis for 2 years, and quarterly reports will be produced for each sampling event. Once samples are collected and submitted to the analytical laboratory, a 21-day turnaround time for stable chemistry analytical data and for radiological analytical data is routine. Additionally, approximately 21 days will be required for analytical data verification and validation and preparation of a draft report. It is anticipated that 14 days will be required by the U.S. Department of Energy (DOE) for review of the draft report. An additional 21 days will be required to resolve and incorporate comments to the draft report and produce a final report. A typical groundwater sampling event is anticipated to take approximately 75 calendar days from sampling until submittal of the final report.

After the eight quarterly groundwater sampling events are evaluated according to 6 CCR 1007-2, Appendix B, Section B3(G), Section B3(H), and Section B4(B), the frequency of groundwater monitoring may be reduced to semiannual events if no analytes are detected in amounts above regulatory limits or if no statistically significant increases in analyte concentration over background are observed. The semiannual sampling events will continue until sufficient water quality analytical data are accumulated for DOE to petition for closure of the site. Semiannual reports will also require a similar amount of time for preparation.

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# 6.0 Assessment Monitoring

If an analyte is detected in concentrations over regulatory limits or a statistically significant increase or trend in analyte concentration over background values is detected, the well or wells exhibiting the increase will be resampled and assessment monitoring, as defined in 6 CCR 1007-2 Section B4(B) and Section B5, will occur. The assessment monitoring will be performed in accordance with procedures and requirements specified in these regulations.

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# 7.0 Quality Control

Quality control will be implemented to ensure that the measurement data collected meet the objectives of the groundwater monitoring program. Quality Control will be implemented by strict adherence to approved sampling procedures governing documentation of sampling activities and sample custody, equipment and materials; sample collection methodology; and collection, analyses, and the evaluation of field and laboratory QC samples. Field and laboratory QC shall be maintained and documented as outlined below.

## 7.1 Field Quality Control

Sample collection will be performed in accordance with the Rulison QAPP and with approved contractor procedures. Samples will be collected in properly cleaned, laboratory-prepared containers, using equipment that has been properly decontaminated. Field QC samples will be collected as indicated below.

### 7.1.1 Field Duplicate Sample

One duplicate environmental sample will be collected from a hydraulically downgradient well during each sampling event and analyzed for the same suite of analytes. Each duplicate sample and sample fraction will have an assigned sample identification number to minimize handling, analyses, and data evaluation bias. Parameter analysis and sample management and documentation for the duplicate will be identical to that for the environmental samples.

### 7.1.2 Matrix Spike and Matrix Spike Duplicate Sample

Additional sample volume will be collected from one hydraulically upgradient well during each sampling event, in order to support a MS/MSD request for all analytes. The MS/MSD aliquot shall be designated by the field supervisor on the Analysis Request and Chain of Custody Record.

### 7.1.3 Equipment Rinsate Blank Sample

To assess the effectiveness of the purging equipment decontamination procedure, one equipment rinsate blank sample will be collected during the sampling event and analyzed for the same suite of analytes as the environmental samples. The equipment rinsate sample will be collected by pouring deionized water through the sampling equipment into appropriate sample bottles. These samples will be subjected to the same sample management and documentation procedures as the environmental samples.

### 7.1.4 Trip Blank Samples

Trip blank samples will be used during the sampling event to document the potential occurrence of contamination of samples during transport to the analytical laboratory. The trip blanks will be prepared by the laboratory and shipped to the site with the sample containers. Trip blanks will consist of two 40-milliliter amber-glass volatile-organic analysis vials filled with deionized water at the laboratory. One set of trip blanks will accompany each shipping cooler with volatile organic compound (VOC) samples. These samples will be subjected to the same sample management and documentation procedures as the environmental VOC samples.

## 7.2 Laboratory Quality Control Samples

Laboratory QC will be maintained as specified in the Rulison QAPP (DOE, 1995b) using the standard procedures established by the laboratory. Method blank, laboratory control sample and laboratory control duplicate samples will be analyzed and used to evaluate method and instrument accuracy and precision. Analytical data quality will be assessed for bias, precision, and completeness using standard data quality indicators expressed as relative percent difference, percent recovery, and percent complete. Any data discrepancies that exceed contract limits will be addressed by the laboratory as appropriate, and all nonconformances will be documented within the analytical report.

## 7.3 Calculation of Data Quality Indicators

Analytical data quality will be assessed, in part, using the methodologies presented in the approved contractor procedures and the Rulison QAPP (DOE, 1995b).

# 8.0 Sample Documentation and Custody

As outlined in the Rulison QAPP (DOE, 1995b), samples will be handled in accordance with approved contractor procedures to maintain sample integrity from collection through analysis. Any significant change or nonconformance in technical procedure shall be documented.

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# 9.0 Analytical Procedures

Analytical procedures will follow established laboratory procedures based on the EPA methods referenced in Table 3-1. Sample preparation and analytical methods to be used in this task are cited in the Rulison QAPP (DOE, 1995b). Instrument calibration, calibration source traceability, analytical QC, and QC acceptance criteria will be in accordance with the contractor laboratory's quality assurance plan and with the contract Statement of Work between the DOE and the laboratory.

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# 10.0 Data Reduction, Validation, and Reporting

The assigned contractor analytical laboratory will perform initial data reduction and validation. Data reported by the laboratory will meet method and laboratory QC requirements. The laboratory will analyze duplicate laboratory control samples for indicators of bias and precision and will report results as percent recovery and relative percent difference. The analytical report will include the QC acceptance criteria for bias and precision. The laboratory will provide a summary data report and will archive all raw data, bench sheets, and other relevant information in a retrievable manner.

## 10.1 Measurement Data and Sample Collection Documentation Review

The ESSC will verify sampling and analytical data generated under this Plan for analytical contract compliance. This includes review of analyte quantitation (reporting) limits and QC indicators. The ESSC Project Manager will provide documentation of the verification process with transmittal of the verified data package and the final report. Data will be verified as set forth in approved contractor procedures.

## 10.2 Data Assessment

Following receipt of validated and verified analytical and sampling data, the ESSC Project Manager will assess the analytical results for COC detection criteria.

## 10.3 Data Reporting

The contractor laboratory will transmit summary analytical and laboratory QC data to the ESSC. The analytical report will be in electronic and hardcopy form and generated from a single source. The analytical laboratory will archive all raw data, notes, and bench sheets until those records are requested by the DOE. The ESSC Project Manager will transmit all original field and sample custody documentation, verification and validation documentation, and the analytical report to the DOE/NV Rulison Site Manager as part of the report. The ESSC will prepare a report presenting the data in tabulated form to the DOE/NV Rulison Site Manager. The ESSC Project Manager (or designee) will submit all original documentation to the DOE at the completion of the project. Copies of all documentation shall be maintained in the ESSC Rulison Site File.

### *10.4 Quality Reports to Management*

In an effort to improve data quality for future projects, ESSC reports will identify areas of concern encountered during project sampling and analysis efforts and possible resolutions. Additional quality reports to management will include nonconformance and corrective actions and the results of assessments.

# 11.0 Nonconformances and Corrective Actions

Nonconformances are items or activities that do not meet the project requirements of approved procedures. Unlike variances which are preapproved and controlled, they are unapproved deviations. Nonconformances to the activities specified in this Plan will be documented and evaluated in accordance with approved contractor procedures.

Whenever possible, corrective actions will be applied to rectify or prevent reoccurrence of nonconformances or other conditions that could adversely affect the quality project data. Corrective actions will be implemented in accordance with approved contractor procedures and the Rulison QAPP.

## 11.1 Assessments

Following approved contractor procedures, the ESSC Project Manager, the ESSC Health and Safety officer, and/or a Quality Assurance representative will conduct assessments of the sampling activities when necessary. Items reviewed may include, but are not limited to, sample collection and handling, documentation, sampling technique, equipment calibration, maintenance procedures, and health and safety practices.

The contractor analytical laboratories participate in system audits as part of the procurement selection process. Results for performance audits at the contractor laboratories are on file at the DOE. The contractor laboratories are also required to participate in external performance audits, or evaluation programs, sponsored by the EPA or other state accredited organizations.

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# 12.0 Records Management

Completed records generated during sampling and analysis will be submitted by the ESSC Project Manager to the DOE/NV Rulison Site Manager for archival at the DOE Nevada Operations. The DOE/NV Rulison Site Manager responsible for this task will submit all documentation to the Nevada Operations records center upon completion of the project.

The laboratory shall retain all raw analytical records generated in conjunction with this monitoring plan available for inspection upon request. These records shall include instrument tuning and calibration records, batch quality control sample data, control charts and calculations, sample tracking and control documentation, raw analytical sample data, and analytical results. These records shall be retained for a duration of time specified in the contract Statement of Work until requested by the DOE (13.0, Document Review).

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## 13.0 Document Review

This monitoring plan will be reviewed at a minimum of every five years to assess sampling methods, techniques, and results. If a modification of the plan is warranted, a document revision process will be initiated.

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# 14.0 References


CCR, see Code of Colorado Regulations.

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DOE, see U.S. Department of Energy.

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